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ABSTRACT

This book is designed to provide teachers with interdisciplinary, action oriented environmental activities for grades K-12 concerning the issue of waste. The activities are organized into three sections and several subsections. The first section contains 29 activities pertaining to natural resources and pollution in subsections involving needs and wants, natural resources, cycles, water, water pollution, oil, and air pollution. The second section contains 31 activities pertaining to solid waste in subsections involving the nature of the solid waste problem; litter; current solutions; and the concepts of reduce, reuse, and recycle. The third section contains 29 activities pertaining to hazardous waste in subsections involving industrial wastes, decision-making, and household hazardous substances. Each activity provides background information about the issue and procedures to carry out the activity. Six appendices contain a list of activity sources and the activities listed by source, by age group, by school subject, by topic, and alphabetically. (MDH)

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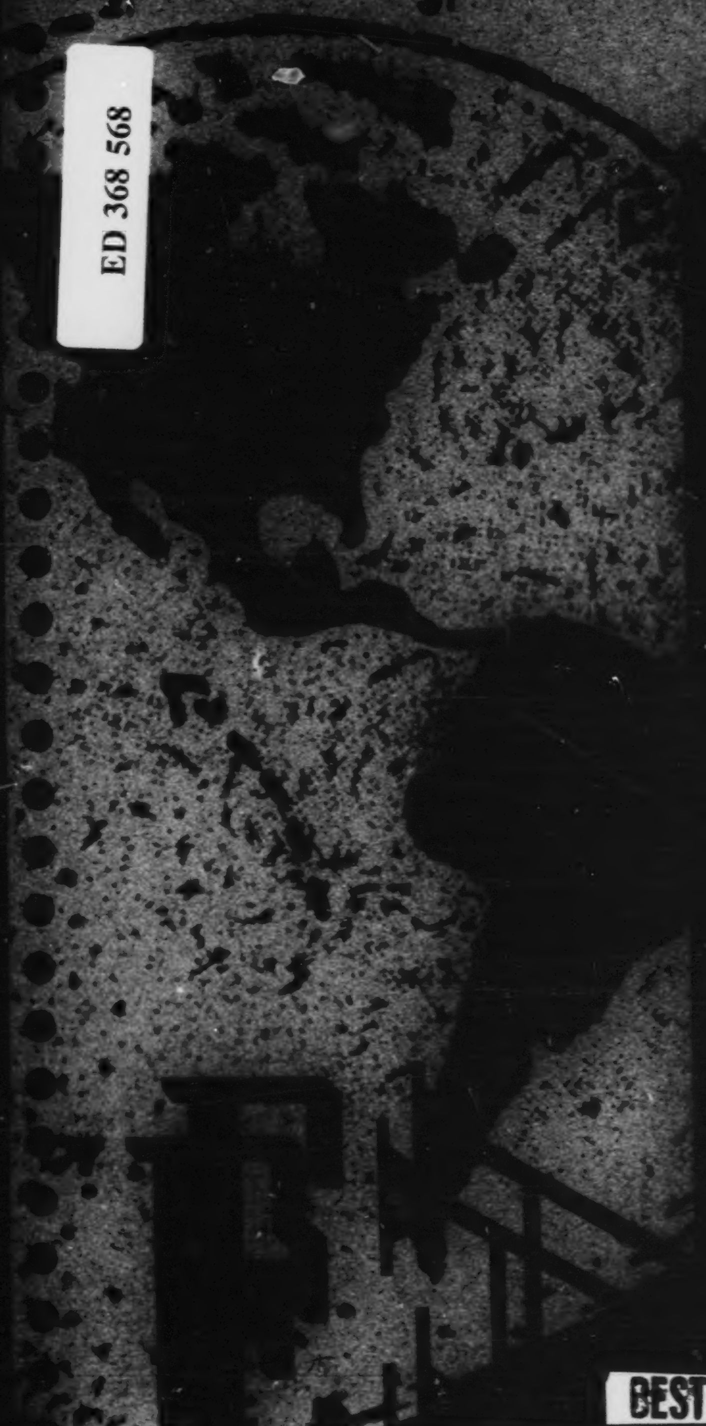

The No Waste Anthology

A Teacher's Guide to Environmental Activities K-12

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The No Waste Anthology

A Teacher's Guide to Environmental Activities K-12

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1. *California Class Project.* Orange County Superintendent of Schools Office
2. *California State Environmental Education Guide.* Alameda County Office of Education
3. *Class Project.* National Wildlife Federation
4. *SLEUTH.* Municipality of Metropolitan Seattle
5. *GREAT (Groundwater Resources and Educational Activities for Teaching).* Iowa Department of Natural Resources
6. *Groundwater: A Vital Resource.* Tennessee Valley Authority
7. *Hazardous Waste Curriculum.* Missouri Department of Natural Resources
8. *Household Hazardous Waste Curriculum.* San Bernadino County Department of Environmental Health Services
9. *Connections: A Curriculum for an Appropriate Technology for 5th and 6th Grades.* National Center for Appropriate Technology
10. *Living Lightly on the Planet.* Schlitz Audobon Center
11. *The Fourth R.* San Francisco Recycling Center
12. *The Hazardous Waste Kit.* The Federation of Ontario Naturalists
13. *Toxics in My Home? You Bet!* Golden Empire Health Planning Center
14. *Toxics: Taking Charge.* Alameda County of Education
15. *TVA - A World of Resources.* Tennessee Valley Authority
16. Wagner, Rich. *The Incredible, Edible, Chemical Landfill.*
17. *A-Way With Waste. 2nd and 3rd editions.* Washington State Department of Ecology
18. *Waste: A Hidden Resource.* Tennessee Valley Authority
19. *Water Precious Water, Book A.* AIMS Education Foundation
20. Van Zandt, Steve. *Banana Slug String Band Songs.*

INTRODUCTION

The purpose of this book is to provide teachers and other educators with environmental activities for classroom lessons, K through 12. This book is a compilation of activities from a variety of sources. The majority of activities selected are interdisciplinary and action oriented. The activities provide opportunities for students to participate in cooperative problem-solving and decision-making tasks. All lessons point toward pollution prevention through awareness, attitudes and action.

The California Department of Health Services, Toxic Substances Control Program staff developed this book as a component of the Public Education program in an effort to share some of the very good work created by many entities. This effort was undertaken in the belief that there was no need to "reinvent the wheel" yet there was a need to organize some of the many possible activities into one document. All activities have been field tested and subjected to peer review.

This document treats the subjects of natural resources and pollution (air, water and soil) and waste (both solid and hazardous). It does so in the hope that as students become more knowledgeable of the environment in which we live, a more sustainable future will be shaped.

HOW TO USE THIS BOOK

This book is organized into three sections and several subsections. The first pertains to Natural Resources and Pollution, the second to Solid Waste, and the third to Hazardous Waste. All subsections are prefaced with a Background Sheet and Glossaries.

Each activity includes a Teacher's Box which lists the goals, suggested subjects, appropriate grade level, "average" time for implementation, and necessary materials. Activities include an introductory background, the procedures for implementation and possible discussion questions.

We encourage each educator to bring your own professional knowledge to these activities. Use the book as a springboard for your experience and expertise. Modify and adapt the activities to the needs of your classroom and school. The purpose of the book, after all, is to make individuals and groups more aware of the environment; its problems, possible solutions and how each person can make a difference.

This document is designed for classroom implementation only. Reproduction for purposes of profit are forbidden.

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NEEDS AND WANTS

BACKGROUND

People have different ideas about what defines "needs" and "wants" depending on their culture, background, values, and situation. For example, in our culture electricity might be viewed as a need but millions of people around the world live happy and productive lives without electricity. Similarly, a computer might be considered a need by many business people while other people would consider a computer a want, not a need.

In this activity, students will examine things in their lives to determine the difference between "needs" and "wants".

The students will have different feelings about what is a need or a want; allow them to express their own ideas. Some of the items illustrated in the student activity pages were purposely chosen because they could be viewed as either needs or wants, depending on the student. To help students express their ideas, they create simple poems called cinquains that have five lines. Cinquains are a wonderful way to combine feelings and facts about our world into a poetic image. They are easy to create as well as fun.

Although every person has different ideas about what is necessary to him or her, there are certain basic needs that all humans share, including biological needs (food, water, air, and shelter), social needs (clothing, feelings of belonging, and protection), and spiritual needs (faith, hope and love). Students will explore some of these needs in this activity.

Goal:
Students will distinguish between personal wants and needs.

School Subject:
Language Arts, Science, Social Studies, Mathematics.

Grades:
3rd - 6th

Materials:
- Scissors
- One set of duplicated activity pages per pair of students
- One envelope for each pair of students
- Paper for each student
- Pencil for each student

PROCEDURE

1. Make copies of the "Needs and Wants" activity pages so that each pair of students will have a set. Cut the cards along the dotted lines and place each set of cards into an envelope (students can help do this).

2. Divide students into pairs. Pass out one envelope of cut-up cards to each pair. Direct student pairs to sort the cards in their envelopes into piles so that the things in each pile are alike in some way. Ask students to share with the class the "rule" they sorted by. On the board, begin a class list of ways to sort the objects. Allow students several opportunities to re-sort the objects, encouraging them to look for new ways to sort.

SAMPLE CINQUAINS:

WATER
Wonderfully wet
Trickling, roaring, moving
It feels so cool
Wetness

WIND
Waving, blowing
Moving rain clouds
Nice on my face
Breath

3. Have students put the cards back into the envelopes, then discuss with students the difference between needs and wants. Ask: Could you live without the things you need? The things you want? Ask students to sort the cards according to needs and wants, then discuss which things they think are needs, which are wants, and whether different people have different ideas about what they need.

4. Tell students that there are certain things, called basic needs, that everyone absolutely has to have in order to stay alive and healthy. Ask which of the things on the cards are basic needs and list student responses on the board. Ask students if they can think of any other things not on the cards that might be considered basic needs. Add appropriate responses (trees, animals, and love, for example) to the list.

5. Explain to students that they will create poems of five lines called cinquains about one or more of the basic needs listed. Write on the chalkboard the sample cinquain or a cinquain you create. Explain to students the rules for cinquains:

First line: 1 word, giving title

Second line: 2 words describing title

Third line: 3 words expressing an action

Fourth line: 4 words expressing a feeling

Fifth line: 1 word, a synonym for the title

Have students work alone or in pairs creating these brief, evocative poems, then ask students to share their creations with the class or in smaller sharing circles.

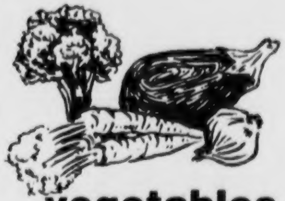
DISCUSSION/TEST QUESTIONS

- Why are basic needs important to us?
- Are there things people do to protect these basic needs?
- What is the difference between a need and a want?
- Is there anything that you consider a need that someone 100 years ago (or in another country today) might consider a want?

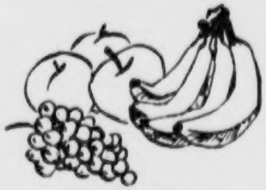
Adapted from the ***California State Environmental Education Guide, 1988***

NEEDS AND WANTS

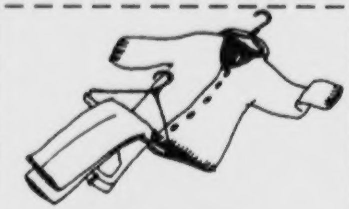
(cut cards apart)



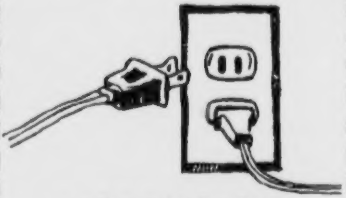
vegetables



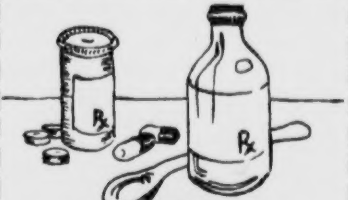
fruit



clothes



electricity



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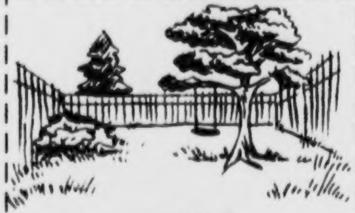
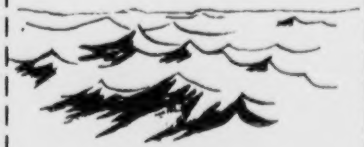


yard



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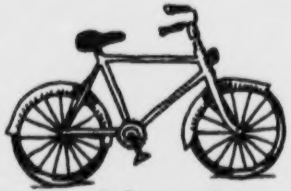
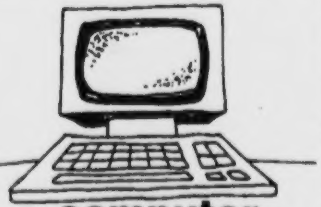
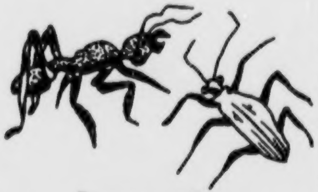


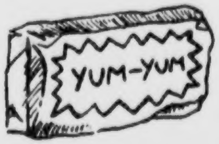
bicycle



computer



insects



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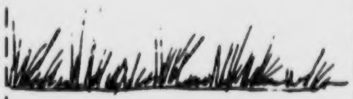

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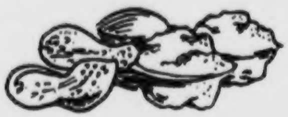
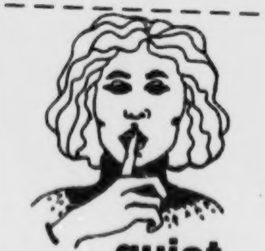


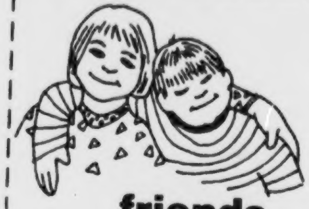
nuts

NEEDS AND WANTS

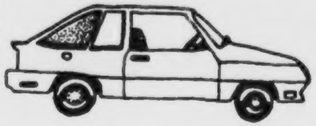
(cut cards apart)



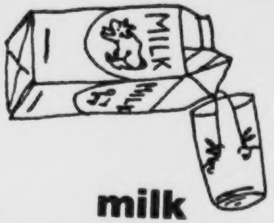
quiet



friends



car



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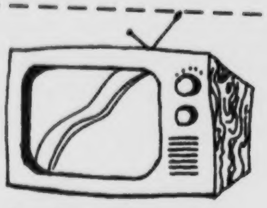

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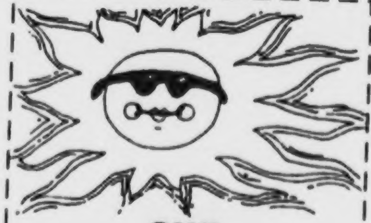
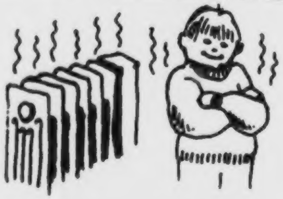


sun



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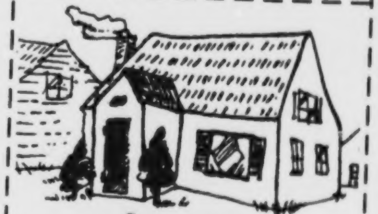

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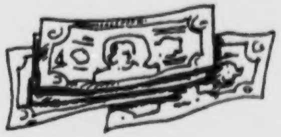

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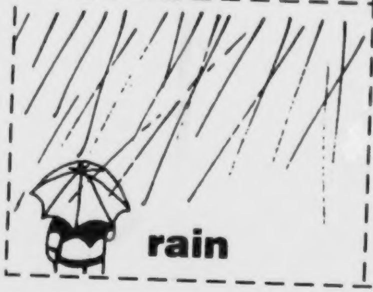

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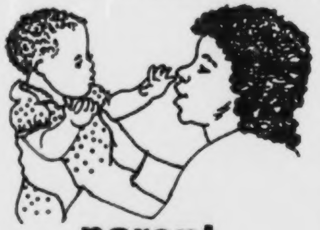
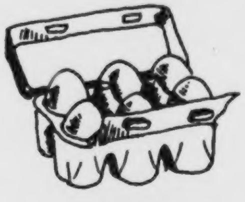


parent



eggs

air

TAKE A BITE OF THE FINITE

Goal:
Students will understand that some resources, including resources lost in landfills, are finite.

School Subject:
Social Studies, Mathematics.

Grades:
6th - 12th

Time:
One class period

Materials:
- Beads of various colors

PROCEDURE

Version One

1. Select beads of different colors to represent resources that often end up as wastes.

2. Scatter beads throughout the classroom and have students divide into teams representing countries. (Make sure some of the beads are hidden so well that they will not be immediately found.)

3. Give teams time intervals of three minutes, one minute, and 30 seconds to explore for resources.

   a. After each exploration, students are to separate and categorize beads.
   b. Discuss the greater difficulty in finding resources during the second and third period of exploration.
   c. Is competition for resources emerging between countries? Think of examples.

4. What can you do to extend the life of finite resources? What are the advantages of extending the life of resources? (More resources available in the future, lessening of international conflict).

see chart on next page

Version Two

1. Hide beads throughout the room keeping the colors in large groups to represent concentrated ore deposits. Hide some beads very well. Also hide one or two differently colored beads to represent rare strategic metals such as chromium and titanium. Divide students into countries:

   a. two superpowers (such as U.S.and the Soviet Union), 3 students to a country
   b. two small industrialized countries (such as Japan and Sweden), 1 student each
   c. four developing, third world countries (such as Brazil, India, Zimbabwe, Guinea), 4 students each

The number of countries can be changed but the relative numbers should be kept the same. The idea is to reflect the world's unequal distribution of population and resources.

2. Have students consider the implication of the fact that some rare strategic minerals may be found in countries controlled by hostile or repressive governments.

3. Have students explore the possibilities of what to do about local shortages of resources. Possible

solutions include: recycling, conservation, trading, treaties, etc.

4. Given the ideas outlined in this activity, have students develop their own learning activity or game.

DISCUSSION/TEST QUESTIONS

- How does competition for natural resources contribute to international tension?
- What is the relationship of competition for resources and war?
- How do nations try to control finite natural resources?
- What happens when nations try to control the supply of finite natural resources?

Color	**Beads**	**Finite Resource**	**Estimates of Global Reserve (1982)**
a. blue	150	aluminum in bauxite	5,100 M(illion)metric tons
b. red	294	tin	10,000 M metric tons
c. purple	1	silver	261,818 metric tons*
d. green	15	copper	511 M metric tons
e. yellow	3	iron in ore	98 M metric tons
f. orange	4	lead	146 M metric tons

1 long metric ton = 2,200 pounds

* converted to Avoirdupois

NOTE: The numbers of beads reflect a mineral's relative, estimated total abundance -- not the mineral's ease of extraction or potential availability.

Adapted from ***A-Way With Waste, 1985***

NATURAL RESOURCES: HANDLE WITH CARE

Goals:
Students will identify some of their own uses of renewable and nonrenewable resources, determine which are essential for their survival, and suggest ways they might change their lifestyles to make more careful use of natural resources.

School Subjects:
Social Studies.

Grades:
7th - 12th

Time:
2-3 class periods

PROCEDURE

Define the terms "renewable" and "nonrenewable". (Some nonrenewable resources are: petroleum, tin, aluminum, coal, copper, lead, and natural gas. Some renewable resources are: solar energy, hydroelectricity, and wood.) Ask your students to list the renewable and nonrenewable resources in products they have used or consumed in the past 24 hours, classifying each product as: (1) essential for survival, (2) necessary for maintenance of their present lifestyle, or (3) a luxury. This list can be made using words and/or images. For example, students can draw pictures of each of the products they have used in the past 24 hours, accompanying these with images or words identifying each of the natural resources from which the products are made.

After looking at the lists and discussing them, students will propose alternatives for each item listed in categories 2 and 3, making an effort to replace items which they believe are inefficient or wasteful. A master list of the resources used and the proposed alternatives can be created in the form of a display. Questions such as these might be discussed with the students:

1. Which, if any, items listed in the "essential" category are really not essential? What are your criteria for evaluating an item's necessity?

2. Which, if any, items listed in the second category are luxuries? On what basis do you judge an item a luxury?

3. What would be the environmental and economic impact of switching to your alternatives? Would it increase your use of renewable resources? (For example, switching from aluminum foil to wax paper would accomplish this.) Or, would it increase your use of nonrenewable resources? (Switching from paper cups to most plastic cups would have this effect.) How would changes in the production and consumption of these products affect the economy?

4. Look at the list of luxury items. Which items could you give up without a major change in your lifestyle?

5. Make a list, beginning with the easiest item to give up and ending with the most difficult. Could you give up the top three items on this list for a day? A week? A month? Try it.

6. Think of several ways to reuse or recycle items you determine you could not give up.

7. Identify some of the economic, cultural, and environmental repercussions of any changes you

make or recommend. Consider the implications if your entire family, school, community, and nation made such changes.

Adapted from ***A-Way With Waste, 1985***

NONRENEWABLE RESOURCES: HOW LONG WILL THEY LAST?

PROCEDURE

Examine Chart A.

1. Which column under the heading "Life Expectancy in Years" do you think is more accurate in estimating the length of time our nonrenewable natural resources will last? What are some factors leading to the accelerated use of resources?

2. Examine the "static use" column under the heading "Life Expectancy in Years". Which nonrenewable natural resource will be used up first?

Ask: Which countries have the highest reserves of the resource? Locate these countries on a world map.

Ask: Why does the U.S.A. need to be concerned with the depletion of this resource?

3. Which nonrenewable resource will last the longest according to the static index? According to the projected rates index?

Ask: Which countries have the highest reserves of this resource?

Ask: With which countries will the U.S.A. need to cooperate in order to get the amount of this resource it needs?

4. Which resource is most extensively recycled? List items you use that contain this resource. Which of these items could you recycle?

5. List the resources that will probably be used up within the next 40 years given projected use rates.

Ask: What role do recycling and careful use play in extending the availability of these resources?

Goals:
Students will:
- learn the estimated life expectancies of selected nonrenewable natural resources.
- understand the role recycling plays in meeting the demand for certain nonrenewable resources.

School Subjects:
English, Social Studies (Geography, Contemporary Problems).

Grades:
7th - 12th

Materials:
Chart on Selected Nonrenewable Natural Resources for each student

How can we determine how long a given resource might last? Any projections are based on two major sets of assumptions: We must estimate the potentially available supply at existing (or future) acceptable prices and with existing (or improved) technology, and we must estimate the annual rate at which the resource may be used.

"There is no danger whatever of humanity 'running out' of nonfuel mineral resources, and I have not said there is. Humanity is not destroying them. What *will* run out, however, is the capacity of the environment to absorb the punishment associated with mining ever-lower grades of ore or reconcentrating what is already dispersed. Secondarily, the ability to do the job at an attractive cost will also 'run out'."

Paul Erlich

Adapted from ***A-Way With Waste, 1985***

CHART A

Selected Nonrenewable Natural Resources; Their Life Expectancies and Prime Consumers

	A	B		C	D		E
Resource	1988 World Estimates of Reserves	Countries or Areas With Highest Reserves*		Percent of Resource Imported for U. S. Needs 1987	Life Expectancy (in years) Static Use at 1976 Level	Life Expectancy (in years) Use Growing at Projected Rates	Amount Recycled Worldwide 1988
Aluminum in Bauxite	21,800,000 thousand metric tons	Guinea Australia Brazil	25% 20% 12%	97%	312	63	No bauxite recycled. In the U. S., 50% of all aluminum cans were recycled
Chromium	1,030,000 thousand metric tons	Rep. of S. Africa U.S.S.R.	80% 9%	75%			Chromium contained in purchaseed stainless steel scrap accounts for 25% of demand
Copper	350,000 thousand metric tons	Chile European & Free Asian Markets U.S.A.	24% 17% 16%	26%	63	36	Old scrap—520,000 tons or 23% of consumption New scrap—200,000 tons
Gold	1,416 million troy ounces	Rep. of S. Africa European & Free Asian Markets U.S.S.R.	53% 20% 14%				Old scrap—1.7 million troy oz or 50% of consumption New scrap—2.6 million troy oz
Iron in Ore	72 million short tons	U.S.S.R. Brazil Australia	34% 15% 14%	22%	172	62	There is no significant recycling of iron ore. In 1987, iron and steel recycled as scrap totaled 750 million tons.*
Lead	75,000 thousand metric tons	Centrally Planned (Socialist) Economics Australia U.S.A.	26% 21% 14%	17%	172	25	Recovery of lead from scrap batteries—570,000 tons
Platinum Group Metals	1,810,000 thousand troy ounces	Rep. of S. Africa U.S.S.R.	88% 10%	88%			200,000 oz. from nontoll scrap 1.7 million oz. scrap
Silver	9,000 million troy ounces	European & Free Asian Markets Canada Mexico	33% 13% 13%	57%	20	17	Old scrap—25 million troy oz or 21% of consumption New scrap—54 million troy oz
Tin	4,260,000 metric tons	Malaysia Indonesia Brazil	26% 16% 15%	72%	41	31	Old and new scrap—15,000 tons

Sources: Columns A, B, and C—U. S. Bureau of Mines, ***1989 Mineral Commodities***,
Column D—***Global 2000 Report***,
Column E—U. S. Bureau of Mines, ***1989 Mineral Commodities***.

* ***Scientific American***, Sept. 1989, Vol. 261, No. 3, p. 148.

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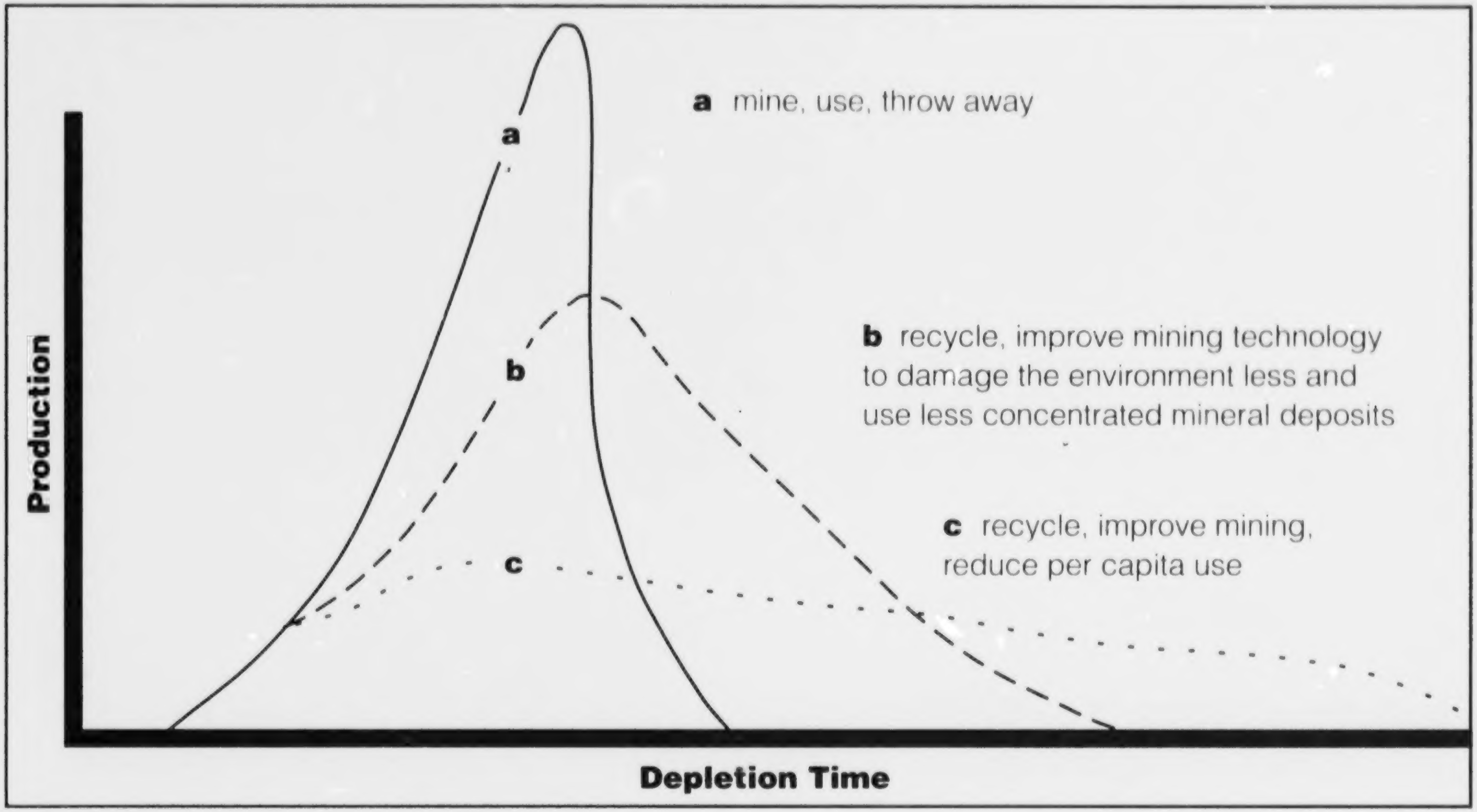


Erlich, Paul. ***Social Science Quarterly*** Vol. 62, No. 1, March 1981.

WHAT'S IN A CYCLE?

Goals:
Students will be able to identify, compare, and evaluate how cycles are important.

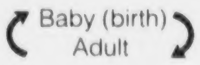
School Subjects:
Social Studies, Sciences

Grades:
2nd - 5th

Time:
3 class periods.

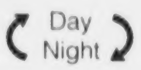
PROCEDURE

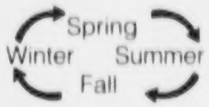
1. Explain to students that cycles are an important aspect of life on earth. A cycle may go through many phases, yet it always arrives back at the point of origin. Thus, cycles ensure that life can go through many changes, and yet maintain stability. Write on the board and examine the following cycle of life:


Baby (birth)
Adult

We could also include in this cycle the many stages from birth to death to new birth. However, in simplest terms, this cycle shows how life is able to change, through new birth, and yet remain stable. The new life is patterned after the old.

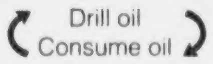
2. Explain to students that there are endless cycles around us. Ask: Can you think of any?




Spring
Winter
Summer
Fall

3. Cycles are also important to our everyday lives. Can you draw a cycle of your typical Tuesday at school? A cycle of your typical week? What would happen if every day or every week were completely different, that is without repeating pattern? (You couldn't build on the past, wouldn't be able to accomplish as much, wouldn't be able to cope with so much change.)

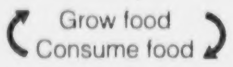
4. Once any step in a cycle is disrupted, the cycle stops or is changed. What is wrong with this process?


Drill oil
Consume oil

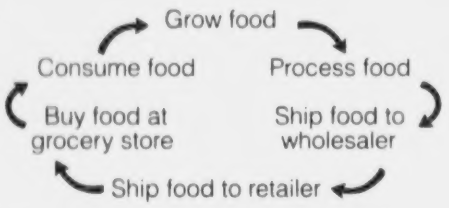
(This process cannot go on forever - oil is not a renewable resource.)

5. Cycles ensure survival. Compare these two cycles:

A.


Grow food
Consume food

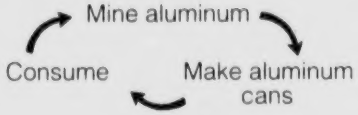
B.


Grow food
Process food
Ship food to wholesaler
Ship food to retailer
Buy food at grocery store
Consume food

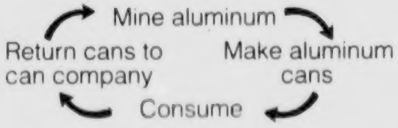
Which of these cycles of food consumption represents our lifestyle?(B) Which cycle can be more easily disrupted?(B) Why? (Because it involves more steps and could be interrupted by unforeseen outside forces disrupting the continuum of the cycle.) Which cycle is more dependent on nonrenewable natural resources?(B)

Ask: What is a nonrenewable resource? Can anyone give an example of a nonrenewable resource? (A natural resource is nonrenewable because of the great length of time needed for its formation. Petroleum is a good example of a nonrenewable natural resource.) What are some other nonrenewable natural resources you can think of? List on the board.

A.



B.



Which is a cycle? What part of "B" is a true cycle while "A" is not? Draw in the arrows. What is the last stage in "A"? (lost in the landfill.)

What is the true cycle in "B" called? (recycling) What is the advantage in recycling? (saves nonrenewable resources, conserves energy)

6. Using another nonrenewable natural resource from the list on the board, draw another cycle that is made possible by recycling.

DISCUSSION/TEST QUESTIONS

- What is meant by the term "nonrenewable natural resource"?
- List three nonrenewable natural resources.
- How does recycling conserve natural resources?
- List 2 nonrenewable natural resources you conserve by recycling.

Adapted from ***A-Way With Waste, 1985***

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HOW VERY LITTLE IT MUST BE

PROCEDURE

Goals:
Students will:
- Gain experience calculating parts per million(ppm) and parts per billion (ppb).
- Understand how proportionally small both a part per million and a part per billion are.
- Understand that a very little of some contaminants goes a very long way.

School Subjects:
Mathematics, Chemistry.

Grades:
11th - 12th

Time:
1 class period.

1. We now have the technology to measure chemicals in the parts per million (ppm) or even parts per billion (ppb) ranges. What do these terms mean?

(A part per million is a proportion in which one unit of a substance is found in a million units of surrounding material such as air, soil, or water. One part per million is proportional to one second in twelve and a half days (300 hours). A part per billion (ppb) is a proportion in which one unit per billion is measured. One part per billion is proportional to one second in 32 years.)

2. Provide students with the following information:
- Clear Lake is a 100 acre lake with an average depth of 25 feet.
- Swimming Pond covers one acre with an average depth of 10 feet.
- Deep Rock Aquifer extends over 50 square miles with an average depth of 6 feet.

Drinking Water Standards

Listed below are some of the chemicals or compounds that can contaminate our drinking water with the corresponding California maximum contaminant levels (MCL) and the Federal standards.

Benzene - 0.005 ppm = 5 ppb
- 0.001 mg/l (MCL)

Arsenic, Lead
- 0.05 ppm = 50 ppb
- 0.05 mg/l (MCL)

2,4-D - 0.10 ppm = 100 ppb
- 0.1 mg/l (MCL)

1,1,1 Trichloroethane (TCE)
- 0.2 ppm = 200 ppb
- .200 mg/l (MCL)

Fluoride - 4 ppm = 4000 ppb
- 1.4-2.4 mg/l (MCL)
(depending on annual average of maximum daily air temperature)

Conversion Table

1 cubic foot = 7.48 gallons
1 gallon = .1337 cubic feet
1 acre = 43,560 square feet
1 square mile = 27,878,400 square feet

3. Using the information above, have students solve the following problems: (Answers are given in parenthesis)

A. The California Department of Health Services (DHS) Investigations unit is attempting to track down the parties responsible for dumping 5 gallons of the herbicide 2,4-D in Swimming Pond. If the chemical becomes evenly dispersed what would be its concentration in ppm? (1.534) In ppb? (1,534) Should the DHS restrict access to Swimming Pond? Why?

B. The State Highway Patrol has notified the Department of Health Services that six gallons of benzene were accidentally spilled into Clear Lake. If it is evenly dispersed, what would its concentration be in ppm? (0.00738) In ppb? (7.38) Should the residents who depend on the lake for drinking water be notified? Why?

C. An old rusted, unmarked 55 gallon drum was discovered on the property of a resort near Clear Lake. Although the manager suspects it may contain a hazardous chemical, he asks his assistant to get rid of it any way he can. Calculate the concentration of contaminant in groundwater if a 55 gallon drum of the chemical were illegally disposed of in an old well and dispersed evenly throughout Deep Rock Aquifer(0.000879 ppm or 0.879 ppb).

What if the same quantity of the chemical were illegally disposed of in Clear Lake? (.0675 ppm or 67.5 ppb); in Swimming Pond? (16.9 ppm or 16,900 ppb)

D. Suppose a 5,000 gallon tank truck loaded with the chemical Arsenic ran off the highway and all the chemical spilled into Clear Lake. What would be the concentration of the chemical in the lake? (6.138 ppm or 6,138 ppb) Does this violate the federal and/or state standards?

4. Have students compare their calculation to the drinking water standards for all the chemicals listed above.

Ask: Which "incident" was the worst in terms of contamination? Which scenario(s) didn't violate any of the standards? How many of the cases violated the benzene standards? The TCE standard? etc.

5. Discuss possible ways of dealing with each of these problems. (Calling the Department of Health Services about a spill; determining civil or criminal penalties for violators; educating the public as to potential threats to human health and to fish and wildlife; restricting access to contaminated waters; developing plans to prevent similar contaminations in the future, etc.)

Adapted from ***A-WAY WITH WASTE, 1990***

WHAT ARE PARTS PER MILLION?

A part per million refers to a concentration of a substance where one unit of the substance can be found in a million units of the surrounding air or water.

- One part per million is one second in 12 days of your life.
- One part per billion is one second in 32 years of your life.

- One part per million is one penny in $10,000.
- One part per billion is one penny in $10,000,000.

- One part per million is one pinch of salt in 20 pounds of potato chips.
- One part per billion is one pinch of salt in 10 tons of potato chips.

- One part per million is one inch in 16 miles.
- One part per billion is one inch in 16,000 miles.
- One part per trillion is a six-inch step on a journey to the sun.

ppm = parts per million

ppb = parts per billion

ppt = parts per trillion

g = gram

kg = kilogram

mg = milligram

1 **mg/kg** = 1 **ppm** = 1,000 **ppb** = 1,000,000 **ppt**

One milligram per kilogram refers to a concentration of a substance (usually in a person or foods) where one milligram of the substance is present for each kilogram of mass (weight) of the person or food. For example, a concentration of 2 mg/kg in a 50 kg person means that the person contains 100 mg of the substance.

Adapted from ***THE HAZARDOUS WASTE KIT, 1985, & INVESTIGATING GROUNDWATER***

WATER

BACKGROUND INFORMATION

There are a growing number of issues revolving around our use of water and our impact on aquatic systems.

We have been manipulating and managing water to meet our needs since ancient civilizations utilized the waterwheel. Our increasingly sophisticated water management techniques have allowed us to control the flow of mighty rivers and transform deserts into flourishing cropland. In the United States, billions of dollars have been spent to create two billion dams, 50,000 public and private water utilities, and irrigation systems for 60 million acres of land.

In the course of meeting our water needs, we have drastically altered our landscape, changing the course of rivers and draining millions of acres of wetlands. Reflections on the impact of our attempts to manage water resources have led to a call for a more integrative approach to water management.

An understanding of the hydrologic cycle and the functioning of aquatic ecosystems increasingly is being recognized as a necessary prerequisite to making water management decisions.

As the most commonly used solvent on earth, water in its cycle, transfers pollutants throughout the ecosystem.

The need for a more integrative approach to understanding and solving the acid rain problem is also becoming more apparent. Airborne pollutants around the globe appear to be traveling hundreds of miles from their source and affecting vegetation, aquatic life, and human health as acid precipitation. It has become an international problem requiring an international pooling of research and control efforts. The extent to which more research is needed before serious efforts to control the problem can be initiated is a matter of ongoing debate, particularly in the United States.

Source: ***LIVING LIGHTLY ON THE PLANET, 1987***

WATER GLOSSARY

Aquifer: an underground bed of earth, gravel, or porous stone that contains water.

Artesian water: underground water trapped under pressure in a porous layer between non-porous rock layers.

Artesian well: a well bored into an artesian aquifer in which the water rises above the top of the water-bearing bed.

Condensation: the process of water changing from a gas (water vapor) to a liquid.

Eutrophication (also cultural eutrophication): overnourishment of aquatic ecosystems with plant nutrients. A natural process except when resulting from human activities such as agriculture, urbanization, and industrial discharge.

Evaporation: the process of water changing from a liquid to a gas.

Groundwater: water that sinks into the soil, where it may be stored for long periods of time in slowly flowing and slowly renewed underground reservoirs called aquifers.

Hydrologic cycle: the complete cycle where water passes from the oceans through the atmosphere, to the land, and back to the ocean.

Hydrosphere: the surface water that covers the earth.

Leaching: the process in which various soil components (such as salts and metals) found in upper layers are dissoved and carried to lower layers and in some cases to groundwater.

Percolation: downward flow or infiltration of water through the pores or spaces of rock or soil.

Precipitation: water from the atmosphere that falls to the ground as rain, snow, sleet, or hail.

Transpiration: the release of water vapor through tiny pores in the leaves of plants.

Water table: the level underground below which the soil or rock is saturated with water, sometimes referred to as the upper surface of the saturated zone.

Watershed: an area from which water drains and contributes flow to a given place, or point, on a stream or river.

WATER CHARADES

Goal:
Through pantomime, students demonstrate the importance of water to humans, other animals, and plants.

School Subjects:
Drama, Social Studies, Science

Grades:
K - 6th

Time:
30 - 45 minutes

Materials:
Set of charade suggestions

BACKGROUND

Water is vital to living things because it is essential to the creation and functioning of living cells. As the major component of animal blood, and plant sap, water transports nutrients to living cells and carries away waste products. Humans are made up of 70% water; a person can dehydrate and die in two or three days without water.

People use water in many more ways than just for drinking. Industry, agriculture, recreation, propagation of fish and other aquatic life and wildlife, hydropower production, navigation, transportation, and waste disposal are some of the other ways we use water.

Even though water covers about 70% of the earth's surface, less than 1% is in the form that people, other animals, and plants can use. Because there is a limited supply for growing populations, it is important that we care for our freshwater resources.

In this activity, through dramatizations, students focus on the importance of water to people and to other living things. Dramatizations such as these enable students to nonverbally express emotions and feelings about water, and allow students to reflect on all the ways we use and rely on water.

PROCEDURE

1. Copy the following list of suggested scenes and cut into separate strips. Make sure there are enough strips for each pair of students to have at least one.

- making a thirsty animal happy
- watering a plant
- a rainy day at school
- the day it snowed
- the year it didn't rain
- a tree or group of trees in a flood
- people rafting down a river
- someone crossing a river by jumping from rock to rock
- a school of fish swimming
- what it feels like to drink a glass of water when you are really thirsty
- birds in a birdbath
- a beaver damming a river with logs
- people swimming in a lake
- a person stomping in a puddle
- people ice skating
- a person taking a shower
- brushing your teeth

2. Discuss with students that clean water is a basic survival need. Divide students into pairs and tell students that they will act out charades

that demonstrate interactions between water and plants and animals (including humans). Hand each pair of students one of the strips you have prepared and allow students five to ten minutes to create their charades.

3. Have teams take turns acting out their charades. After each charade have the rest of the class try to guess what was being enacted. As a courtesy to the actors, be sure that each team is through with its charade before you allow others to guess. Ask students in the audience to describe how the scene showed the importance of water to living things. Make a point of calling on cooperative students to go next.

DISCUSSION QUESTIONS:

Why is water important to people? To other living things?

Why do we need water?

Do we need to be concerned about the kind of water that is available to us? (For example, will salty, soapy, or dirty water do?)

Do the ways that humans use water create problems for other living things or the environment?

Do you think that we can hurt other living things by the things we put in water by mistake or on purpose?

Adapted from ***CALIFORNIA STATE ENVIRONMENTAL EDUCATION GUIDE, 1988***

CHARACTERISTICS IN AN AQUATIC COMMUNITY

BACKGROUND

A dynamic biotic community is dependent upon the integration of the physical, chemical, and biological environmental factors. What better way for students to see this relationship than to visit a nearby stream? The transition periods from summer to fall and from winter to spring are perfect times to take a class on a field trip.

What characteristics determine the life in a stream? Many factors are involved. The velocity of the stream is probably the most important. Stream velocity determines what type of food is present and what feeding strategies are used by the organisms. It also plays a large part in the dissolved oxygen content of the stream. Organisms are adapted to different stream velocities.

Dissolved oxygen content is another important factor. The cool temperatures of mountain streams when combined with the large number of waterfalls and riffles, result in water with high oxygen content. When water temperatures rise, dissolved oxygen goes out of solution and into the atmosphere.

The pH level also affects the distribution of life in a stream. The higher the pH, the more carbonates, bicarbonates, and salts present. Streams rich in these are nutritionally rich and support abundant life. When the pH is 10 or more, the stream will not be conducive to optimum levels of life. When the pH is 5 or below the water will be too acidic for most life forms.

The bed of the stream plays a very important role in determining what types of organisms will be present and also influences the overall produc-

Goals:
Students will:
- Determine the importance of a biotic community and how it relates to our own community.
- Demonstrate that plants and animals within a given community are interdependent.
- Develop the concept that environmental conditions on land vary to greater degree than they do in water.

School Subject:
Science, Mathematics.

Grades:
9th - 12th

Materials:
- Meter or yard stick
- Tin can
- Phenolphthalein solution
- Manganese sulfate
- Potassium hydroxide
- Cork stoppers
- Sodium thiosulfate
- Microscope
- Thermometer
- pH paper
- Sodium hydroxide solution
- 100 ml flask
- Potassium iodide
- Dilute sulfuric acid
- Eye dropper
- Plankton net
- Coffee can
- Secci disk
- Small bottle

tion of minerals in the stream. Sandy bottoms are the least productive, as they offer little substrate for either protection or attachment. It is important for many bottom-dwelling organisms to have a place of attachment to keep them from being swept away by the current. Bedrock is also essentially non-productive, because while it does offer a solid substrate, all life is totally exposed to the current. Gravel and rubble bottoms are the most productive. These bottom types offer large areas for attachment sites and provide abundant nooks and crannies in which crustaceans and insects and their larvae can hide.

PROCEDURE

1. Introduce the class to aquatic communities with a lecture from the background material.

2. Select a pond or stream located near your school.

3. Hand out activity sheets.

4. Divide the class into groups to collect data.

5. Discuss findings.

6. Return to the stream about a week later to observe growth and development.

Adapted from ***GROUNDWATER ACTIVITIES, 1987***

CHARACTERISTICS IN AN AQUATIC ENVIRONMENT
ACTIVITY SHEET

Visit a stream located near your area. Examine the various features of a biotic community by answering the following questions on the data sheets provided.

A 1. How wide is the pond or stream?
2. What is the average depth?
3. Is it sheltered by trees?
4. When does the sun shine on the community?
5. Make a list of the living things you observe in the community.
6. How many varieties of plants and animals are there?
7. How many animal populations are represented?
8. What plants do you find growing on the bank? What plants are found growing on rocks?
9. Do any of the plants grow in the water?

B 1. On your data sheet, keep a record of the plant and animal relations that you observe. Is there any evidence that the plants help the animals? In what way do the animals help the plants? What kind of relationship is this called? Are there any changes in either plant or animal life from week to week? Can you observe the growth and development of living things in either community?
2. Compare your list of observations with those of your classmates.

C 1. What relationship do you see between the living and nonliving things in the community?
2. What is the food chain in the community?
3. Can this food chain be traced?
4. Is the biotic community polluted or becoming polluted? What are the causes of this pollution?
5. What changes are taking place in the stream?
6. What factors are involved in becoming adapted to a certain community?
7. From your observations, what do the location and the amount of sunlight have to do with the population growth in the stream community?

D 1. Mapping

Draw an outline map of the stream or pond. Show the scale of your map and indicate which way is north. Include both natural and manmade features in your map. Label trees, islands, dams, piers, swampy ground, roads, hillsides, and buildings. Make your map as detailed as possible.

2. Water Depth

Carefully measure the water depth at various places. Keep a record of the measurements. You might use a long pole and weighted string to obtain various depth measurements, or use a Secci disk if available.

3. Temperature

Using a thermometer, make a detailed record of both the air and water temperature in several places in the community. Keep in mind that the sun affects the water temperature in shallow and deep parts.

4. Clarity

On your data sheet, record the clarity of the water as tested by a Secci disk. Is it clear or murky? The murkiness is called turbidity. How far does the light penetrate the water? At what depth can you no longer see?

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E. Chemical Characteristics

1. Testing the pH of the water

Is the water neutral, slightly acid, or slightly alkaline? Using the pH paper, compare the color of the pH paper with the colors on the chart provided with the pH paper kit. How does the pH of the water affect plant and animal life in a water community?

2. Carbon Dioxide Content

Carefully add 10 drops of phenolphthalein solution to 100 ml of stream water. Slowly add some sodium hydroxide solution with an eye dropper. Add the sodium hydroxide one drop at a time. Stir thoroughly after each addition. Continue adding sodium hydroxide until a permanent pink color develops. Use the following formula to determine the carbon dioxide content of the stream water:

Sodium hydroxide X 140 = amount of CO2 in water in parts per million.

3. Oxygen Content

Immediately after getting a sample of water from your biotic community, add 1 ml of manganese sulfate to a flask or bottle containing 100 ml of fresh water. Then add 1 ml each of potassium hydroxide and potassium iodide. Stopper the flask and mix thoroughly. Then add 1 ml of dilute sulfuric acid. Put the stopper back in the flask and mix the solution again. Let the water stand for 10 minutes. After this time, add sodium thiosulfate to the water with an eyedropper. Count each drop that you add. Continue until a permanent color change appears. Determine the oxygen in the stream by using the following formula:

Sodium thiosulfate drops X 28 = amount of oxygen in water in parts per million.

F. Biological Characteristics

1. Shoreline or bank vegetation

What kinds of plants grow along the banks? Reeds? Long grasses? Cattails? Describe and identify, if possible, the different plants that grow along the bank or shore. Can you explain why some plants grow there and others do not?

2. Aquatic vegetation

What kinds of plants are growing in the water? Do any of these resemble aquarium plants? Which aquatic plants grow in shallow and which grow in the deep water? At what depth does each grow?

3. Plankton

All microscopic life swimming or drifting in the pond or stream can be termed plankton. Make a plankton tow net to obtain samples. Remove the cover and the bottom of a coffee can. Tie a nylon stocking around the can. Cut a hole in the toe of the stocking and tie a small empty bottle to it (a spice bottle will work well). Punch three holes around the edge of the coffee can for your tow line. Tow the plankton net from one end of your area to the other. Examine the plankton under a microscope provided by your teacher. What kind of organisms do you find? Are there more of these organisms at certain depths? How does this affect the aquatic community?

BALANCE IN AN AQUATIC COMMUNITY

BACKGROUND

This activity introduces students to balance in an aquatic community (an example of the feedback of ecosystems). When in balance, the interactions between plants and animals in aquatic communities function like finely tuned mechanisms. Like synchronized gears in a machine, each member of an aquatic community is dependent on the actions of others to keep the system functioning. If one part of the system becomes unbalanced, the other parts are adversely affected.

This system of checks and balances is inherent not only in aquatic ecosystems, but in all ecosystems whether on land or water. If the interactions between organisms in an aquatic population are compared to the functioning of four gears in a machine, the gears could be identified as follows:

1) The first gear is made up of producers or plants. Different forms of algae play an important role as producers in many aquatic ecosystems. Through the process of photosynthesis, algae produce food and oxygen for other organisms.

2) The second gear consists of the herbivores, such as plant-eating ducks, or fish that help to keep the plant population from getting out of control.

3) The third gear contains the carnivores and omnivores who perform a similar function by keeping the population of herbivores in balance. Animals such as large fish, wading birds, and raccoons would fit in this category.

Goals:
Students will:
- Explain how the roles of producers, consumers, and decomposers are important in maintaining balance in an aquatic community.
- Describe interrelationships between plants and animals found in local aquatic ecosystems.

School Subject:
Science

Grades:
7th - 12th

Time:
1 - 2 class periods

Materials:
- Transparency, student activity sheet

4) The fourth gear keeps the system humming as decomposers recycle dead plant and animal matter, making vital nutrients available for plants.

In this activity, groups of students work together to fit the gears of an aquatic community into a balanced system. A field trip to a local aquatic area is recommended to stimulate student interest and enhance the comprehension of concepts presented. If a field experience is not feasible, contact a local nature center, natural resource agency, or zoology department of a local college to obtain information about plants and animals inhabiting waterways in your area.

PROCEDURE

1. Divide the class into groups of four students and give each student a copy of the blank "gear". Challenge students to use the gears to design a balanced aquatic ecosystem. Let them know that each gear should represent a major category of plants or animals in a stream, lake, or ocean environment and that the gears should fit together to represent the entire community. They will need to make a group decision regarding the category of each gear to make the system balance. To guide them in labelling and fitting the gears together, you might want to have the class generate a list of aquatic organisms found locally.

2. Ask students to write the names of major groups of living things on each gear and list or illustrate examples of organisms to fill each category. If students are unfamiliar with the term, "producers", "herbivores", "carnivores", "omnivores" and "decomposers", write these labels on the board as well.

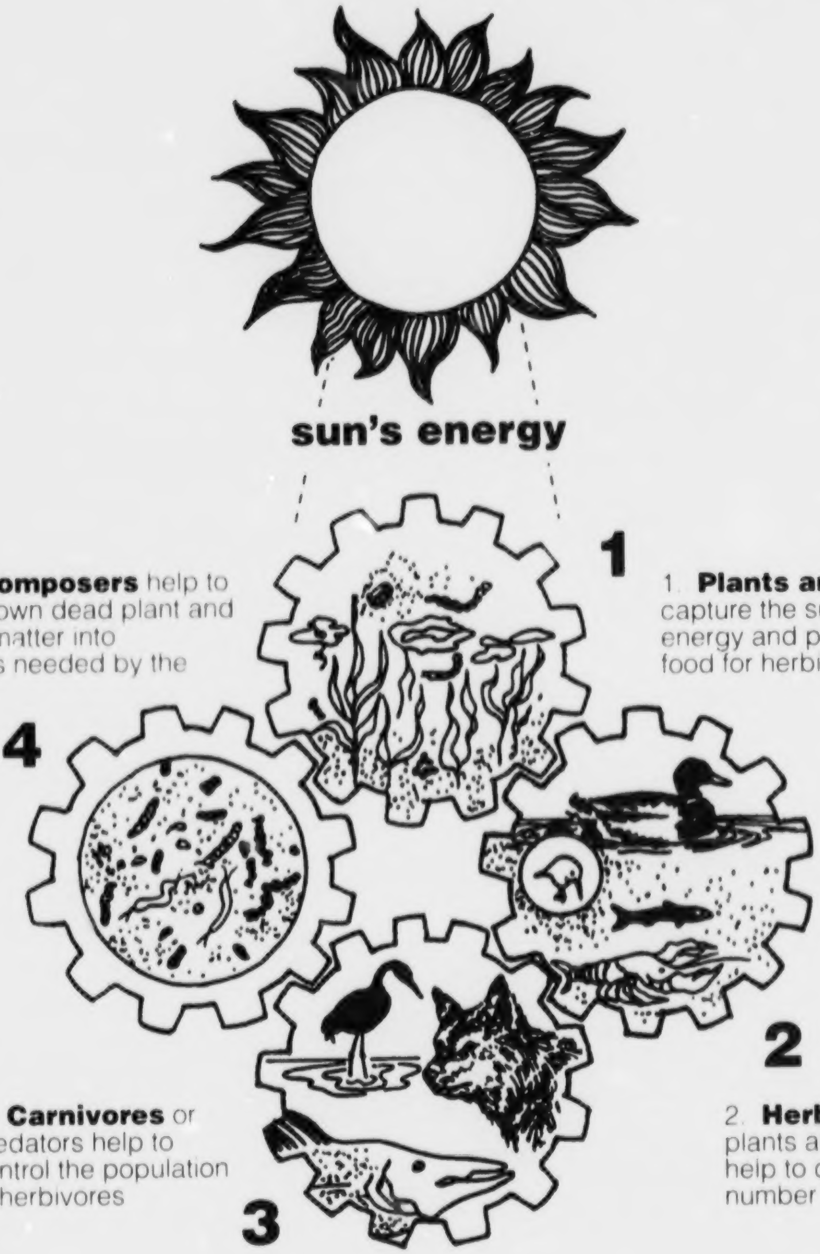
3. When the gears are labeled, ask each group to assemble them into a system. Do they arrange the gears according to interactions between groups of organisms? Do they lay the gears out in a linear or circular pattern?

4. The first group of students to correctly assemble the gears could then present their balanced community to other class members. Ask them to identify the source of energy that keeps the gears in motion and to explain the interactions between each of the gears.

5. The transparency provided could be used to focus class discussion on balance in aquatic ecosystems. Have students fill in the gears with any missing information and then collect them from each group for use in the activity "When the Gears Don't Mesh".

Adapted from ***LIVING LIGHTLY ON THE PLANET, 1987***

A BALANCED AQUATIC COMMUNITY



1. **Plants and algae** capture the sun's energy and provide food for herbivores

2. **Herbivores** eat plants and algae and help to control the number of plants.

3. **Carnivores** or predators help to control the population of herbivores

4. **Decomposers** help to break down dead plant and animal matter into nutrients needed by the plants.

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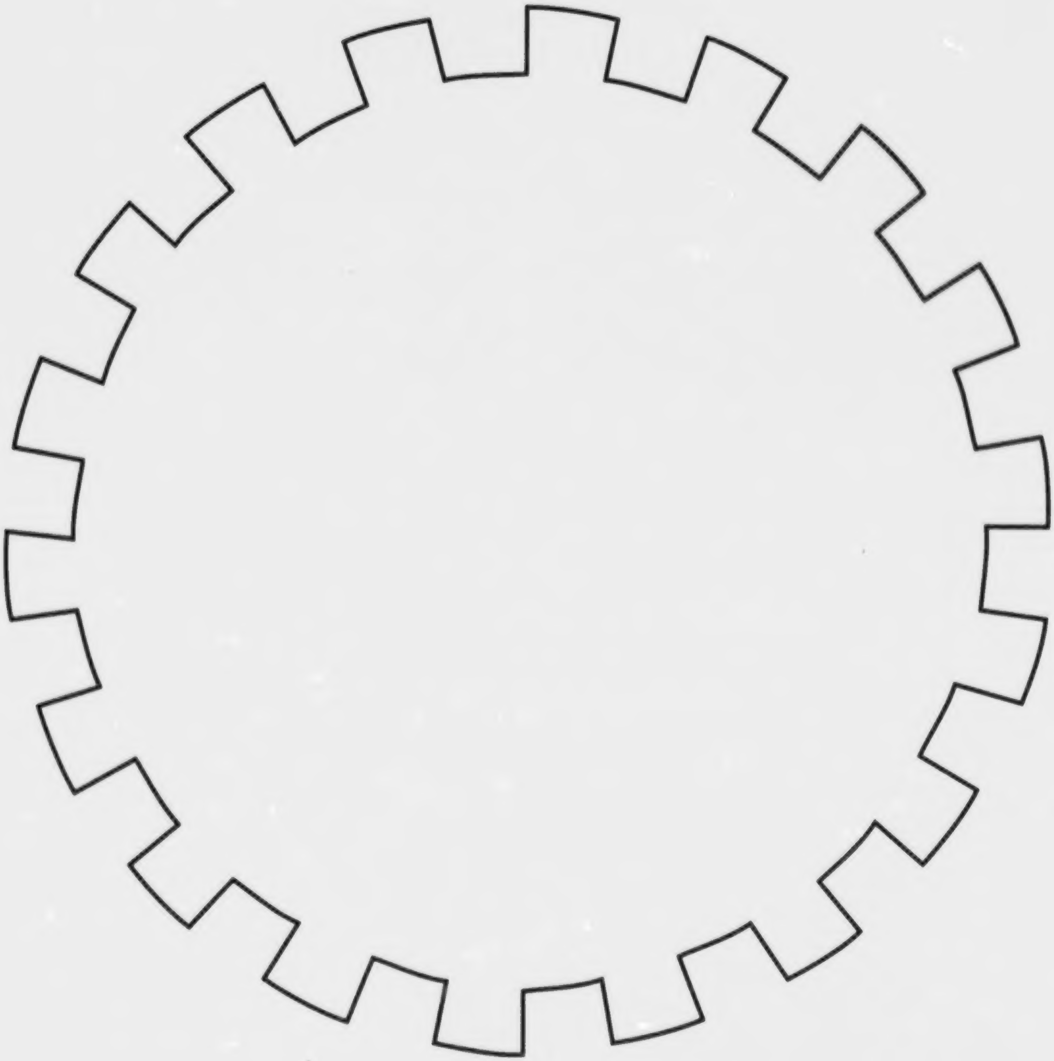
FITTING THE GEARS TOGETHER

STUDENT SHEET



Members of an aquatic community interact like the gears of a finely tuned machine. Each group of organisms is interrelated to the others. Label each of the 4 gears with a category of aquatic plants or animals and fill in the gears with the names and/or illustrations of organisms living in local waterways.

from **Living Lightly on the Planet**, 1987, pg. 42

SUPER CYCLE

BACKGROUND

In order to understand the way that pollutants move through the ecosystem, one must understand the hydrologic cycle.

PROCEDURE

1. Prepare the two 2-liter bottles by cutting around the shoulder of the bottle, forming a "lid". This will be taped back on once the bottle is filled with terrarium items.

2. Have the students review the water cycle with the handout "How Hydrologic Processes Affect the Earth and Its Inhabitants". Stress the meanings of evaporation and transpiration.

3. Ask students to show the movement of water using colored arrows. Use red for precipitation, blue for surface water, green for groundwater, and yellow for water that is evaporating or transpiring back into the atmosphere.

4. Ask: How do plants affect the water cycle? How do animals? Where does water pick up impurities? How? What human activities affect the water cycle?

5. Perform a demonstration using the two 2-liter bottles. Label one "transpiration", the other "evaporation". Put sand and soil in each, and a plant in the "transpiration" bottle. Fill the little bottles half-full with water. Place one in each 2-liter bottle.

Goals:
Students will demonstrate the water cycle.

School Subject:
Science

Grades:
3rd - 6th

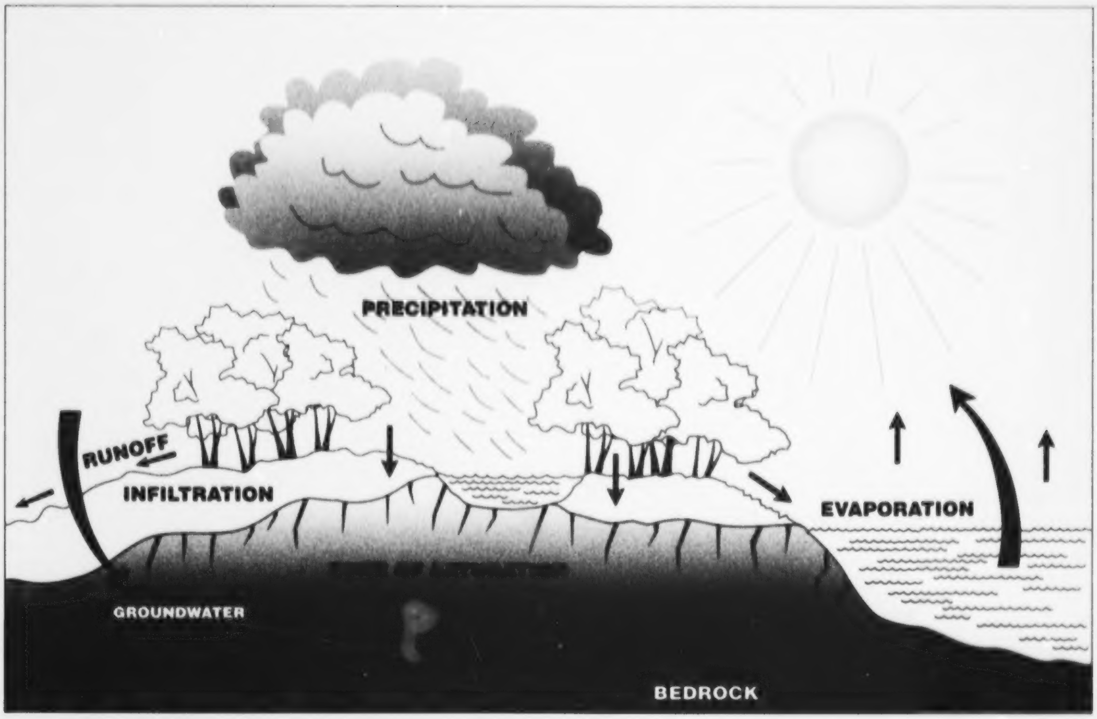
Time:
1 class period, then a few minutes follow-up for two weeks

Materials:
- Colored pens or crayons in red, blue, green, yellow
- Handout of water cycle for each student
- Two recycled 2-liter bottles
- Small houseplants
- Soil
- Sand
- Water
- 2 small recycled bottles

6. Mark the water levels of each little bottle each day. Have the students record their observations.

Adapted from ***TVA: A WORLD OF RESOURCES, 1989***

WATER CYCLE


PRECIPITATION
RUNOFF
INFILTRATION
EVAPORATION
GROUNDWATER
BEDROCK

SOLUBILITY IN WATER

PROCEDURE

1. Either in groups or in class, define the word "solubility". Write it on the board and list the various definitions or suggestions of the students.

2. Which of the following will dissolve in water?

   a) flour
   b) salt or sugar
   c) nail polish remover
   d) cooking oil

What will happen to any that don't dissolve?

3. Fill 4 beakers 3/4 full with cold water. Add 1 tsp. of each substance to the water and stir.

4. Have the class record their observations. Wait one hour and record again.

5. After gathering the data, have the class draw conclusions.

   a) which substances were soluble in water?
   b) what conclusions can the students draw about the ones that did not dissolve? Were they heavier or lighter than water?
   c) what happened to the nail polish remover?
   d) how does solubility affect groundwater?

Goal:
Students will learn that toxics can be dispersed into water by dissolving.

School Subject:
Science

Grades:
7th - 12th

Time:
1 class period

Materials:
- Glass beakers
- Stirring rods
- Flour
- Salt or sugar
- Nail polish remover
- Cooking oil

Adapted from ***SLEUTH, 1982***

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WHAT IS EVAPORATION?

PROCEDURE

1. Either in groups or as a class, define the word "evaporation". Write it on the board and list the various definitions or suggestions of the class.

2. Ask the class which of the following liquids would evaporate first?

a) cooking oil
b) water
c) nail polish remover

How would increased temperature affect the evaporation? How would a lower temperature affect the evaporation?

3. Pour small amounts of each of the three liquids into three small dishes. Label them carefully. It would help if the small dishes were glass and had sides so that you could easily measure any change in volume.

4. Make up a record sheet so that you can monitor the change. For example, you might want to check the amounts after an hour, then after 2 or 3 hours, and perhaps the next day.

5. After gathering the data on evaporation, have the class draw conclusions.

Ask: Which evaporated most quickly? Why did it? Why didn't the others evaporate as quickly? Where did the liquids that did evaporate go? Was the class aware of any of the liquids evaporating? Could any of the liquids be smelled? How long did it take for the room to be filled with the odor of polish remover?

Goal:
Students will discover how substances, including toxic ones, can get into the air.

School Subject:
Science

Grades:
7th - 12th

Time:
1 class period, plus one day follow-up

Materials:
- Petri dishes or saucers
- Cooking oil
- Water
- Nail polish remover

6. Heat the water. Ask the class if evaporation increases, decreases, or stays the same. Do the same with the oil. What happens? Nail polish remover is very flammable and so would be dangerous to heat. What does the class think would happen to the polish remover if it was around heat?

Adapted from ***SLEUTH*, 1982**

USING GROUNDWATER MODELS

BACKGROUND

The following are four experiments to exhibit the processes of groundwater movement.

Goals:
Students can observe the mechanics of the pollution of groundwater.

School Subjects:
Science, geology

Grades:
7th - 12th

Time:
1 class period each

Materials:
- Small aquarium
- Unpainted aquarium gravel
- Two pieces of foam (1cut to the dimensions of the aquarium, the other two inches shorter in length)
- Spray pump
- Plastic straws
- Powdered drink mix
- Food coloring
- Paper towels
- Film canister
- Two rulers
- Water container

PROCEDURE

1. Basic Groundwater Model:

Use aquarium gravel, pump, plastic straw, and foam to build the Basic Groundwater Model shown on page 36. Pour water into the model. Have the students observe, record, and discuss the results. Use the spray pump to show how a well pumps water from an aquifer. Use the plastic straw to simulate an artesian system. (The top layer of foam may need to be weighted to stay in place.)

2. Fertilizer/Pesticide Model:

Build the model as shown on page 36. Sprinkle powdered drink mix on the surface to represent pesticides or fertilizer on a field. Sprinkle water over the surface to simulate rain and have the class observe, record, and discuss the results.

3. Landfill/Abandoned Waste Site Model:

Assemble the model shown on page 36. Roll a paper towel into a ball and saturate it with food coloring. Place it beneath the surface as shown to represent an improperly designed abandoned waste site or old (dump) landfill. Pour water on the surface and observe the results.

4. Leaking Underground Storage Tank Model:

Construct the model on page 36. Puncture a film canister in several places with a pin and fill it with colored water. Place it beneath the surface (not along the side of the aquarium) as shown. Pour water on the surface and have the class observe, record and discuss.

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DISCUSSION/TEST QUESTIONS:

What material in the model is most porous and permeable? (The gravel aquifer)

What material was the least porous and permeable? (The foam)

What happens to the water table when groundwater is pumped out? (It lowers)

How can the water table maintain a constant level? (Water must be poured in at the same rate it is pumped out)

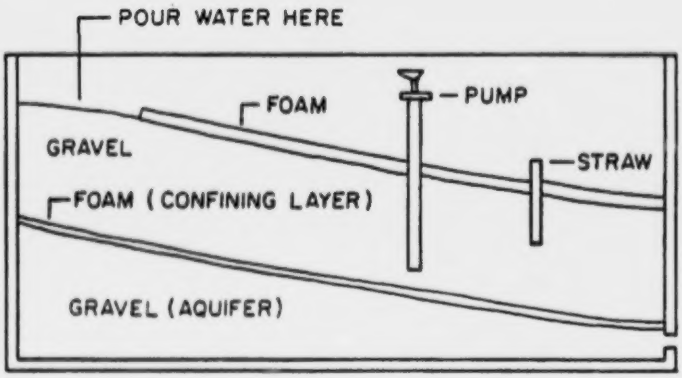
Adapted from ***GREAT, 1989***

Constructing a Groundwater Model

Student Worksheet

Name__________________________

1. Set up the groundwater model as shown.



2. Set a cup at the end to catch water coming out of the hole. Pour water (be ready to measure this) into the model until it begins draining from the hole. Put a piece of tape over the hole. One person can use a nonpermanent marker to draw on the side the path of water as it flows into and through the gravel and mark the water table. Record the amount of water added. ______________________ml

3. Untape the hole and let the water drain and compare the amount collected to the amount poured in. Measure and record the amount of water drained from the model. ______________________ ml

4. How does the amount collected compare with the amount poured in?

5. Put tape over the hole again. Pour in more water until the water table is above the level of the bottom of the pump. Pump some water out of the aquifer. Experiment with putting in water (recharging the aquifer) faster than water is being pumped out, simulating abundant precipitation. Record your observations.

6. Experiment with pumping water out of the aquifer faster than water is poured in, simulating drought conditions. Record your observations:

7. Add water until it is just below the bottom of the drinking straw. Experiment with the position of the model to make water flow out of the drinking straw without pumping to simulate an artesian well. Observe and record your results:

8. Clean up and return equipment.

9. Answer the following:
   a. Which material is most porous? ____________________ Permeable?____________________
   b. Which material is least porous? ____________________ Impermeable? ____________________
   c. What happens to the level of the water table when water is pumped out of the aquifer?
   d. What must happen for the water table to remain at or above the same level as water is being pumped out of the aquifer?
   e. How did the position of the model have to be changed to make water flow out of the drinking straw? Name and define this type of well.

GREAT WAYS TO USE THE GROUNDWATER MODEL

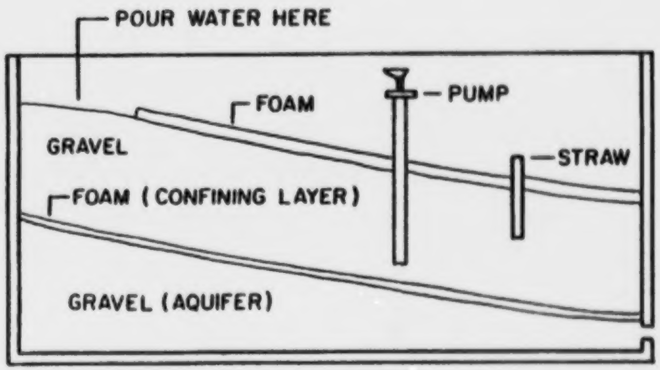

POUR WATER HERE
FOAM
PUMP
GRAVEL
STRAW
FOAM (CONFINING LAYER)
GRAVEL (AQUIFER)

Fig. 1: BASIC GROUNDWATER MODEL

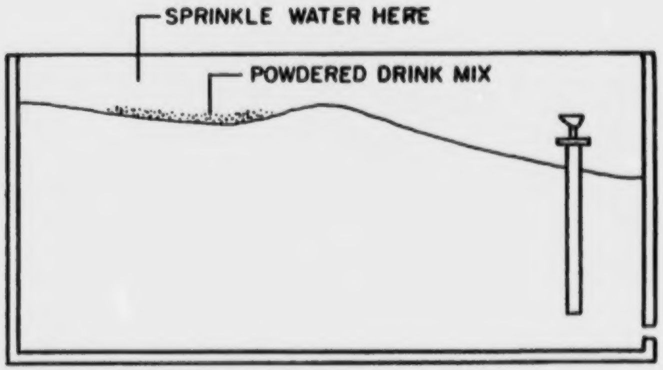

SPRINKLE WATER HERE
POWDERED DRINK MIX

Fig. 2: FERTILIZER / PESTICIDE MODEL

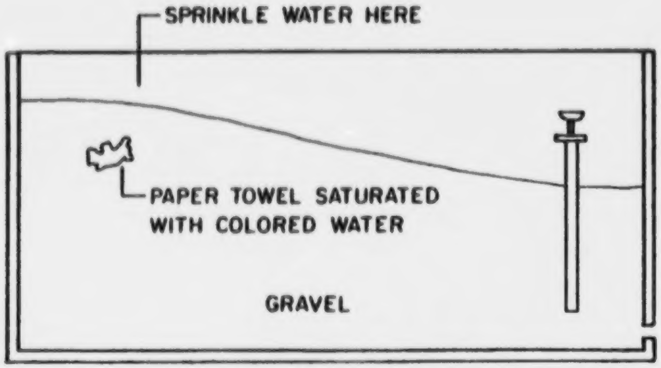

SPRINKLE WATER HERE
PAPER TOWEL SATURATED WITH COLORED WATER
GRAVEL

Fig. 3: LANDFILL / ABANDONED WASTE SITE MODEL

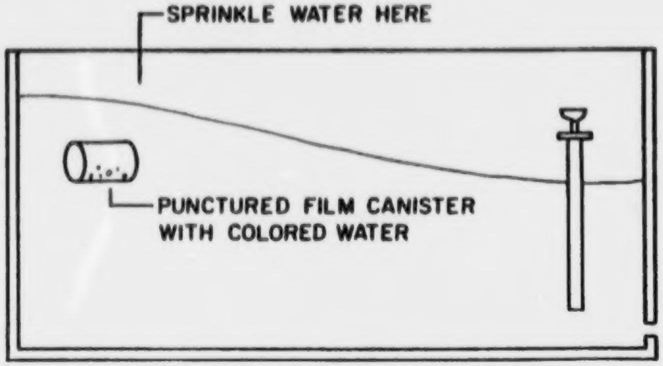

SPRINKLE WATER HERE
PUNCTURED FILM CANISTER WITH COLORED WATER

Fig. 4: LEAKING UNDERGROUND STORAGE TANK

GREAT WAYS TO USE THE GROUNDWATER MODEL

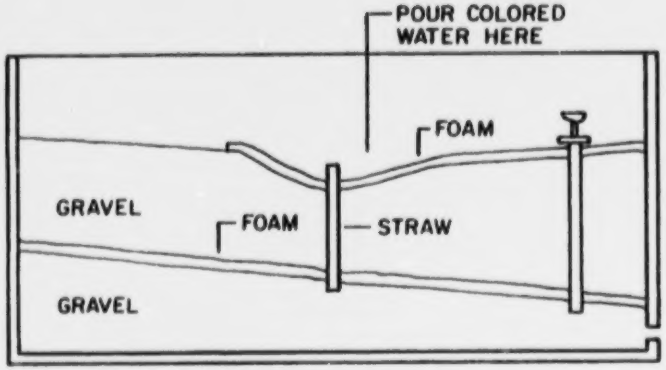

POUR COLORED WATER HERE
FOAM
GRAVEL
FOAM
STRAW
GRAVEL

Fig. 5: AG-DRAINAGE WELL MODEL

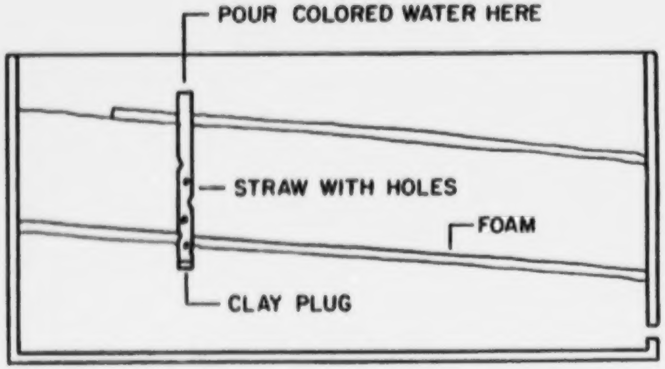

POUR COLORED WATER HERE
STRAW WITH HOLES
FOAM
CLAY PLUG

Fig. 6: ABANDONED WELL MODEL

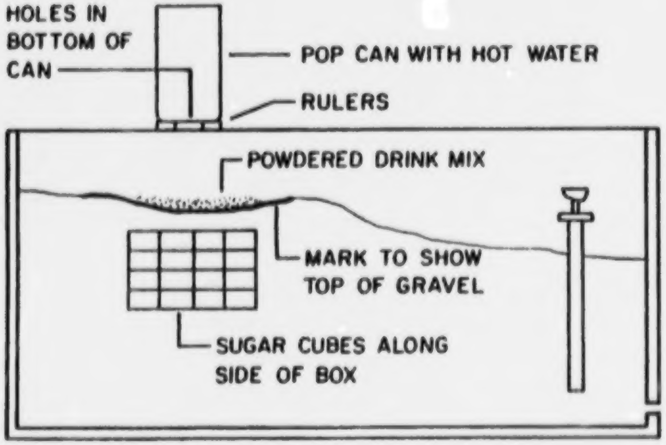

HOLES IN BOTTOM OF CAN
POP CAN WITH HOT WATER
RULERS
POWDERED DRINK MIX
MARK TO SHOW TOP OF GRAVEL
SUGAR CUBES ALONG SIDE OF BOX

Fig. 7: SINKHOLE MODEL

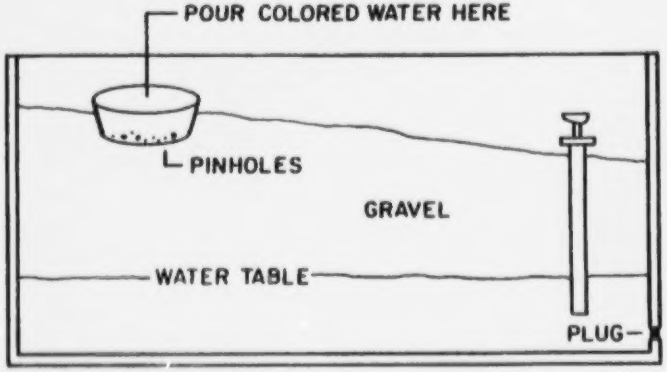

POUR COLORED WATER HERE
PINHOLES
GRAVEL
WATER TABLE
PLUG

Fig. 8: LAGOON MODEL

WHEN THE GEARS DON'T MESH

BACKGROUND

Healthy, free-flowing streams which were once our natural heritage are being transformed all over the globe. For centuries we have dumped a variety of wastes into rivers as a means of moving unwanted materials away from us. The reality that there is no "away" and that pollutants affect our health and the health of the environment has helped to stem the flow of wastes into waterways. But our pollution problems are far from solved.

We have made progress with *point source* pollutants traceable to the point of discharge, such as pollutants from factories or sewage plants. We are also making progress with cutting back *non-point source* pollutants which aren't as easily traced to a source, such as general runoff from farms, suburban lawns and city streets. But a variety of chemicals, fertilizers, and sediments still end up in our waterways, adversely affecting the balance of life in aquatic communities. This activity covers nonpoint source pollutants, with a focus on the kinds of pollutants originating from homes, particularly fertilizer runoff from lawns, and pollutants poured down drains such as detergents, cleaning solvents, and paint products.

Effects of Fertilizer

When nutrient-rich pollutants such as lawn fertilizers or phosphate detergents enter waterways they disrupt the balance of life. They stimulate the growth of algae so that it is out of balance with the rest of the system. Herbivores can't control the excessive algae growth and when the algae begin to decompose, oxygen is removed from the water in the process. The lowering of oxygen then reduces or in severe cases eliminates populations of fish and other organisms. This is called cultural eutrophication.

Goals:
Students will:
- Hypothesize how the balance of life in an aquatic community would be affected by the addition of nutrient-rich pollutants.
- Apply knowledge of the water cycle to determine how materials added to the land end up in waterways.
- Determine how their families could help curb the input of pollutants into local waterways.

School Subjects:
Science, Social Science

Grades:
10th - 12th

Time:
1 - 2 class periods

Materials:
- Transparency designs
- Gears from "Balance in an Aquatic Community"

PROCEDURE

1. Use the transparency of the water cycle to review the process with the students. They should be familiar with the percolation of rainfall into groundwater and the movement of groundwater and runoff into surface waters.

2. Ask the students a series of questions to help them gain some insights into the effect of one common nonpoint source pollutant–lawn fertilizer–on the balance of life in an aquatic community.

   Ask: What is fertilizer and where is it used in the city?

   What happens to fertilizer once it is applied to the soil? (It's taken up by plants, percolates through the soil layers, and some makes its way into groundwater.)

   Where does the rainwater falling on your lawn eventually end up? (some evaporates, some is taken up by plants, some percolates down to groundwater where it could end up in a stream that flows to a river, a lake, or the ocean.)

   How does the action of rain help move the fertilizer from one place to another? (Fertilizer is absorbed in rainwater and moves through the water cycle.)

   Do you think the addition of fertilizer to an aquatic community is beneficial or harmful? Explain.

3. Divide students into groups and hand back the gears of the aquatic community from the activity "Balance in an Aquatic Community". Have students draw up a hypothesis to describe how the addition of fertilizer would affect the balance of life. How would the gears change? Have them expand or cut the gears to fit their hypothesis.

   Refer to the transparency "When the Gears Don't Mesh" for a graphic representation of how the aquatic ecosystem would be disrupted.

4. Conclude the activity with a discussion of what students and their families can do to reduce pollutants from their homes. (Pollutants from lawn runoff can be reduced by cutting back the amount of fertilizer applied to lawns; by not applying fertilizers, pesticides and herbicides when rain is forecast; and by gradually replacing lawns with native vegetation. Consumers can also curb pollutants by choosing detergents without phosphates since they are nutrient-rich pollutants.)

   In addition to fertilizers, pollutants commonly poured down drains also have an impact on water quality. Most toxic chemicals used around the house and discarded down drains will pass through water treatment plants and end up in waterways. To prevent this, the following materials should not be poured down drains:

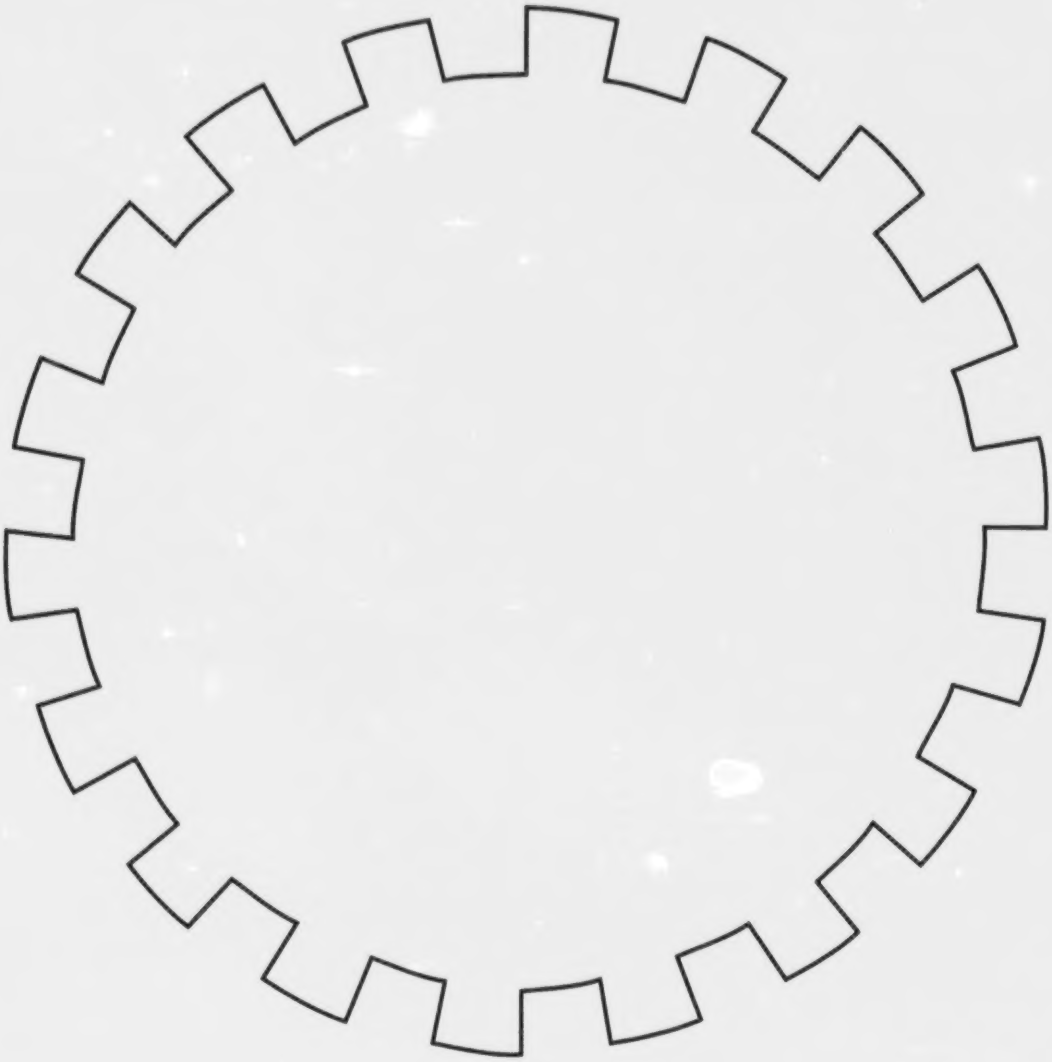
   - paint products
   - pesticides
   - gasoline
   - cleaning solvents
   - degreasers
   - dye
   - disinfectants
   - oil
   - grease

If these products are used, they should be used up and their containers disposed of as recommended by a hazardous waste disposal center.

Adapted from ***LIVING LIGHTLY ON THE PLANET, 1987***

FITTING THE GEARS TOGETHER

STUDENT SHEET

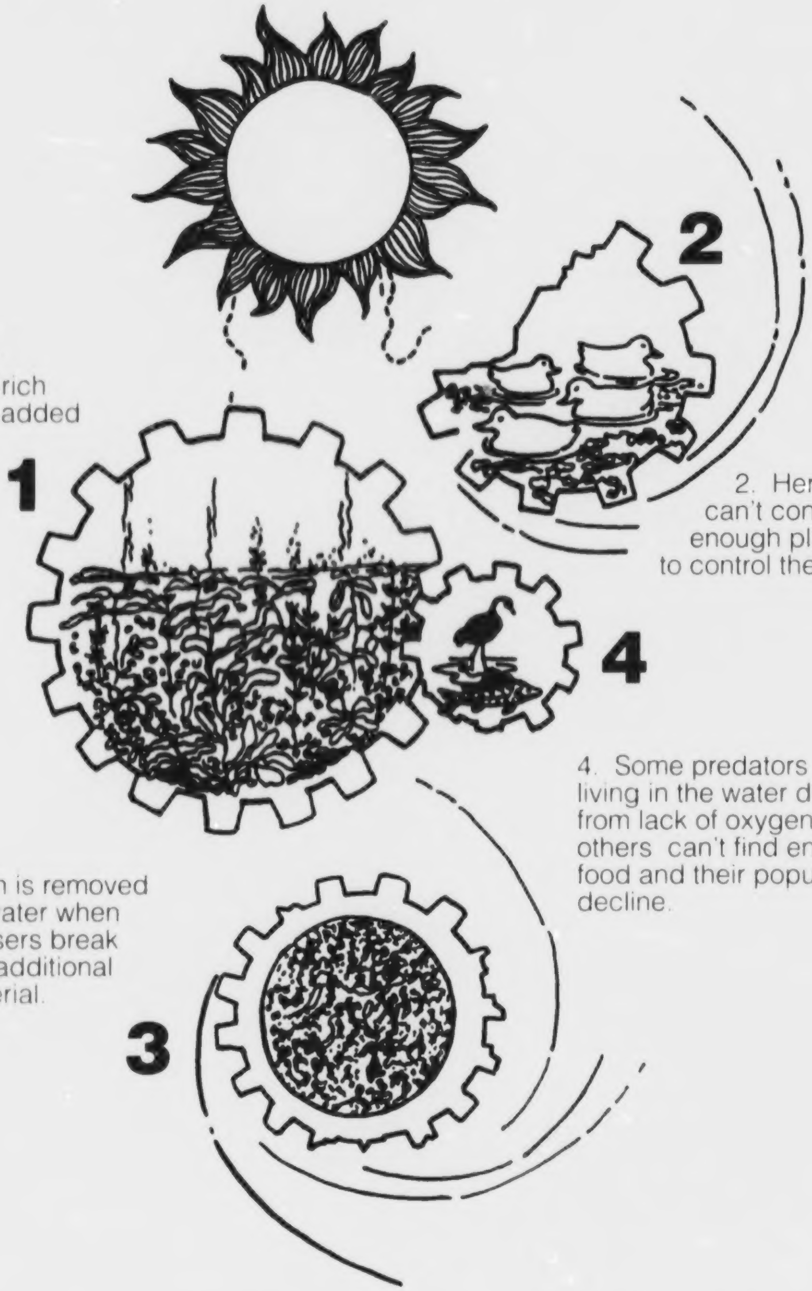


Members of an aquatic community interact like the gears of a finely tuned machine. Each group of organisms is interrelated to the others. Label each of the 4 gears with a category of aquatic plants or animals and fill in the gears with the names and/or illustrations of organisms living in local waterways.

from **Living Lightly on the Planet**, 1987, pg. 42

AN AQUATIC COMMUNITY OUT OF BALANCE

WHEN THE GEARS DON'T MESH



1. Plants and algae multiply when nutrient-rich pollutants are added to the water.

2. Herbivores can't consume enough plants to control them.

3. Oxygen is removed from the water when decomposers break down the additional plant material.

4. Some predators living in the water die from lack of oxygen; others can't find enough food and their populations decline.

Design by Jim McEvoy. Reprinted with permission of Wisconsin Department of Natural Resources.

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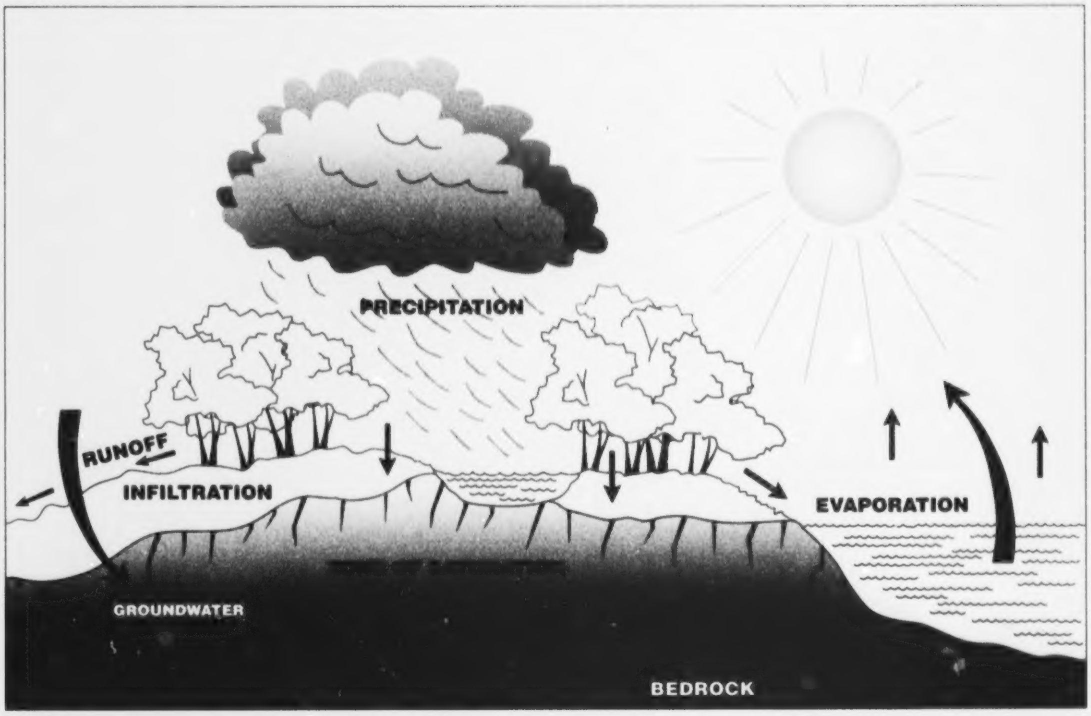
WATER CYCLE


PRECIPITATION
RUNOFF
INFILTRATION
EVAPORATION
GROUNDWATER
BEDROCK

MORE THAN MEETS THE EYE

PROCEDURE

Goals:
Students will:
- Understand how water may be stored in the ground.
- Understand that once contaminated, aquifers are difficult if not impossible to purify.

School Subject:
Science

Grades:
3rd - 5th

Time:
1 class period.

Materials:

TEACHER DEMONSTRATION:
- One household sponge
- Red food coloring
- Eye dropper
- Clear container to catch water
- "Water in Soil" overhead

STUDENT ACTIVITY:
- Several household sponges cut into quarters or halves; one piece for each student. Use different types of sponges to get a variety of results.
- Recycled containers brought by students from home, e.g. milk cartons, cups, etc.

1. Tell students the water they drink and cook their food in may come from underground.

   Ask: Is the ground solid? If so, how can water be stored in the ground?

2. Show students the large sponge. Ask: Is this sponge solid? Can it hold water?

3. Set the sponge over a clear container. Pour water over the sponge until it's saturated. This occurs when the water begins to drip into the container. Empty the container. Ask: Is there water in the sponge? If so, where is it?

4. Explain that the water is filling the "air spaces" in the sponges. Show the overhead, "Water and Soil". Point out the "air spaces" available in the soil. Explain that this is how groundwater is stored. That this saturated sponge is like the ground. Tell the students that some soils are better than others at holding water. (Sandy soils don't hold water as well as clay soils.) Special underground areas that hold lots of water are called aquifers.

   Ask: How much of the sponge is air holes? How much is "solid"? "In the ground the aquifer area will have a porosity (waters holding capacity) of 5 to 50%." —R. Allen Freeze and John A. Cherry, ***Groundwater***

5. Stand the sponge on end. Add one or two drops of red dye onto the saturated sponge. Explain that the dye represents hazardous substances or poisons that if improperly disposed of can contaminate groundwater. For example, weed and bug killers, gasoline or oil from leaking tanks or storage tanks, etc. Note how the "contaminant" begins to disperse throughout the "aquifer".

6. Squeeze the water from the sponge into the clear container and note its color. Attempt to clean the "aquifer" by resaturating the sponge and resqueezing. Keep track of the number of times necessary to do this before the water becomes completely clear again.

   Note: different types of sponges may vary in the number of times it takes to flush the dye out. A sponge that takes a few squeezes could represent sandy soils, another sponge that take many times to purge the dye could represent clay soils.

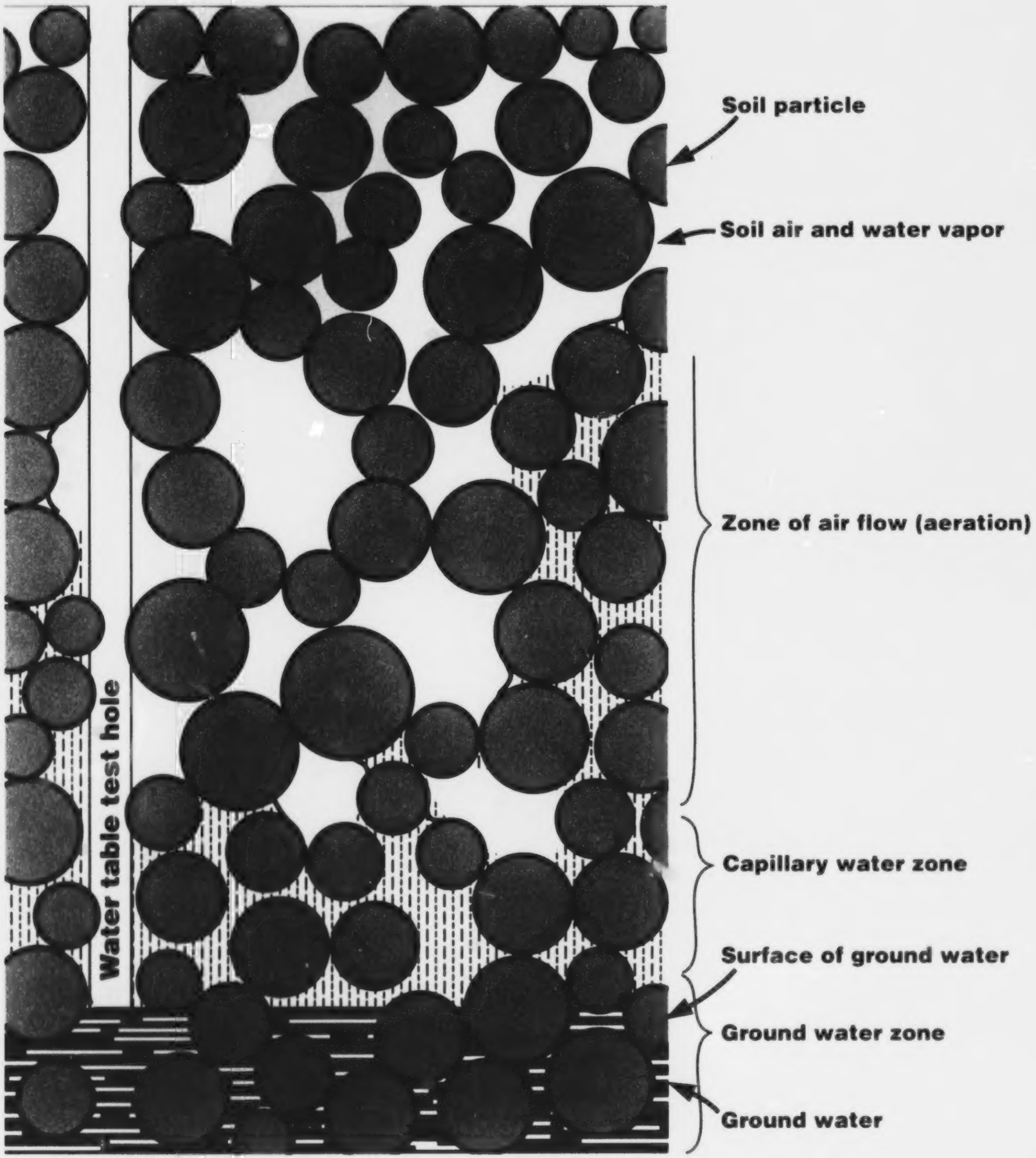
7. **Ask:** What have we learned about groundwater? (That contaminants are impossible or very hard to remove from aquifers; that it may take a long time to wash a contaminant from an aquifer.)

   Ask: What are some of the ways hazardous substances might get into groundwater? (Runoff from farms using pesticides; illegal dumping; pouring household hazardous substances such as furniture polishes or paints down the drain, etc.)

8. **Ask:** What can we do to keep hazardous substances out of our drinking water? (Make sure they are properly disposed of; find safer substitutes, etc.)

Adapted from ***A-WAY WITH WASTE, 1990***

Water in Soil


Water table test hole
Soil particle
Soil air and water vapor
Zone of air flow (aeration)
Capillary water zone
Surface of ground water
Ground water zone
Ground water

Zunker's classification of soil moisture. (Redrawn from Zunker, 1930)

MINI WATER TREATMENT SIMULATION

BACKGROUND

A water company must go through several steps to insure safe and pure drinking water for the community.

The water that is processed comes from the natural water cycle and has usually been transferred and stored in a reservoir before processing. The following steps are found in a typical water treatment plant:

Aeration: water is sprayed into the air to release any trapped gases and to absorb additional oxygen.

Coagulation: to remove dirt suspended in the water, powdered alum is dissolved in the water and it forms tiny, sticky particles, called "floc" which attach to the dirt particles. The combined weight of the dirt and the alum particles (floc) become heavy enough to sink to the bottom during sedimentation.

Sedimention: the heavy particles (floc) settle to the bottom and the clear water above the particles is skimmed from the top and is ready for filtration.

Filtration: the clear water passes through layers of sand, gravel, and charcoal to remove small particles.

Chlorination: a small amount of chlorine gas is added to kill any bacteria or microorganisms that may be in the water.

Goal:
Students will do an activity that simulates the steps in the water treatment process.

School Subjects:
Mathematics, Science.

Grades:
3rd - 6th

Time:
One hour.

Materials:
PER GROUP:

- Clear plastic cups with one cup water and approximately 1/2 tsp. dirt. Stir well.
- Two styrofoam plastic cups (approx. 10 oz.)
- One small piece of paper toweling to use as a filter
- One tsp. powdered alum from drug store
- 1/2 to 2/3 cup clean sand
- 1/4 cup clean gravel
- Two drops of simulated chlorine (do not use chlorine)make a mixture of yellow food coloring in water to simulate adding chlorine for purification

PROCEDURE

1. Discuss water purification. In order to have safe and pure drinking water, the local supply must go through several steps in a treatment process.

2. For each group pass out 1 clear, plastic cup with water that has a 1/2 tsp. of dirt mixed in it. Water that has come through the natural water cycle might not be as dirty as this sample.

3. Pass out the activity sheets to each student; review the steps in the water treatment process.

4. Pass out the materials to each group. Have the students poke 10-12 small holes in the bottom of the styrofoam cup. This will be used as a filter cup. Have extra cups available for more elaborate filtering systems. Have the students record their observations on the activity sheet.

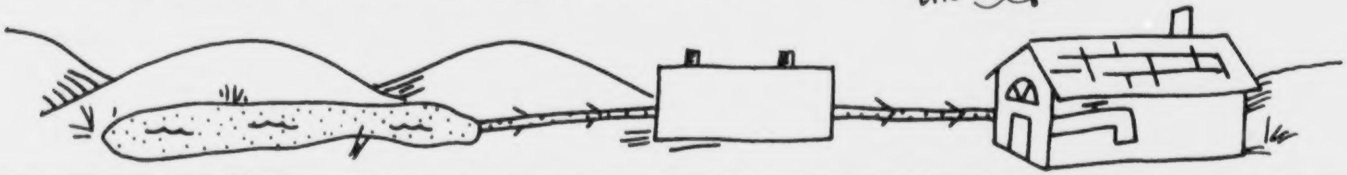
5. Students should add 1 or 2 drops of simulated chlorine bleach to each goups' final water sample. Caution: Do not use real bleach, and do not drink the water!

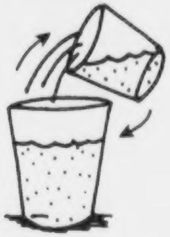
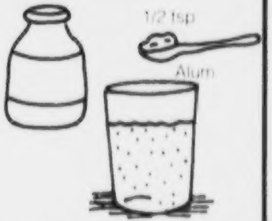
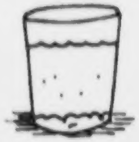
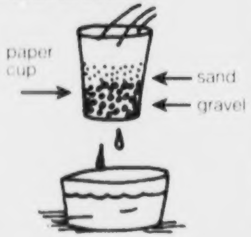
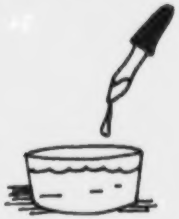
DISCUSSION QUESTIONS:

Compare each of the groups samples and have each group share their method of purification. Discuss what would have happened if the steps were done in a different order. Try again - varying the process and comparing the results.

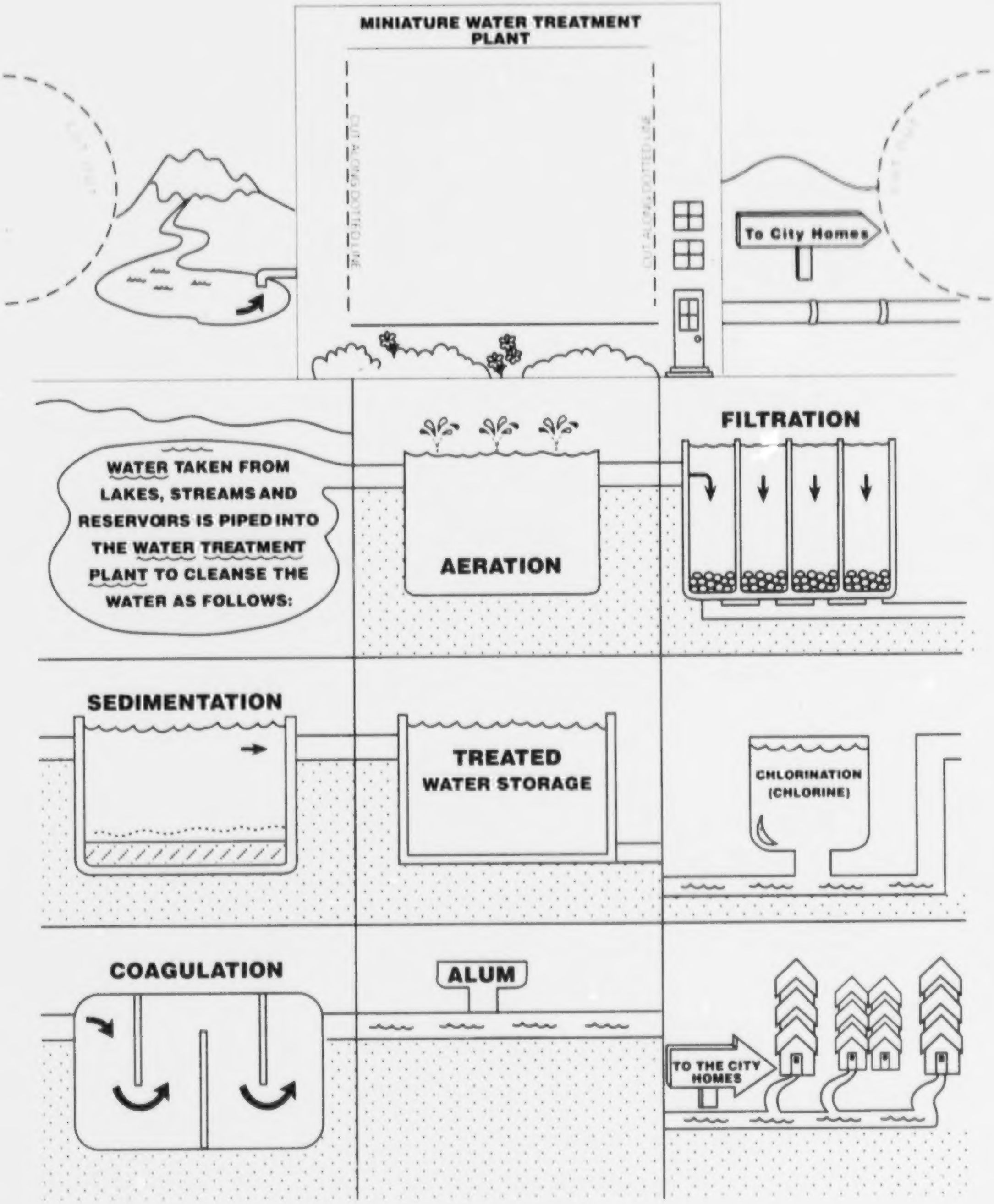
Adapted from ***WATER, PRECIOUS WATER, BOOK A, 1988***

Water Treatment from the Reservoir to the Tap!



Step 1: **Aeration:**	Step 2: **Coagulation:**	Step 3: **Sedimentation:**	Step 4: **Filtration:**	Step 5: **Disinfection:**
				
Aerate water to release trapped gas.	Alum collects small dirt particles forming larger sticky particles called "floc".	The larger "floc" particles settle to the bottom.	The "floc" particles are trapped in the layers of sand and gravel.	A small amount of disinfectant is added to kill the remaining bacteria. The microorganisms are killed by this process. Do not do this step.
Observation:	Observation:	Observation:	Observation:	

Source: **WATER PRECIOUS WATER, BOOK A,** pg 56


MINIATURE WATER TREATMENT PLANT
CUT ALONG DOTTED LINE
CUT ALONG DOTTED LINE
To City Homes
WATER TAKEN FROM LAKES, STREAMS AND RESERVOIRS IS PIPED INTO THE WATER TREATMENT PLANT TO CLEANSE THE WATER AS FOLLOWS:
AERATION
FILTRATION
SEDIMENTATION
TREATED WATER STORAGE
CHLORINATION (CHLORINE)
COAGULATION
ALUM
TO THE CITY HOMES

Source: ***WATER PRECIOUS WATER, BOOK A,*** *pg 57*

BEST COPY AVAILABLE

OIL IN THE ENVIRONMENT

BACKGROUND INFORMATION

Oil can have very serious affects on the environment because it contains hydrocarbons and heavy metals. Students need to learn that oil can be recycled, and that steps should be taken to ensure that oil is not accidentally mixed with water, or in contact with plants, animals, or soil.

Although the effects of environmental pollution often are difficult to see, a major oil spill gives dramatic evidence of the impact on wildlife. Feathers are damaged, embryos are killed when oil seeps into eggs, fish suffocate because their gills become clogged, and marine and land animals die from ingesting food and water contaminated by oil.

People attempt to prevent oil spills and "clean up" after spills take place. Their actions are not always successful and sometimes without knowing it their assistance does more harm than good. For instance, the process of using detergents to clean oil from the feathers of birds caught in a spill can damage the birds' feather structure and arrangement (the birds' waterproofing). Birds may also be more susceptible to disease during this time of stress and may be weakened so that it is more difficult for them to secure food and water. Obviously, the quality of food and water sources also may be affected.

Many of us are impressed by the damage done when a supertanker causes an oil spill. Few of us however realize the environmental impact of our own waste-managing practices.

1. Used automotive oil is the single largest source of oil pollution (over 40%) in our nation's water ways. Most is dumped by people who change their own oil.

- In 1960 service stations performed 90% of automotive oil changes. Today, do-it-yourselfers change about 60% of the automotive oil.
- The used oil is usually dumped on the ground, in trash going to a landfill or down a storm drain leading to streams, lakes, or the ocean.

2. During engine use, oil picks up toxic contaminants, carcinogens, and heavy metals (lead, zinc, arsenic, chromium, and cadmium). If used oil is not properly recycled these toxics are carried into the environment.

3. One pint of oil can produce a slick of approximately one acre on surface water.

- Fish, waterfowl, insects and aquatic life are threatened by used oil in waterways. Floating plankton and algae (a basic food source) are killed by oil.
- Very small amounts of oil rinsed over shellfish beds can ruin the taste of clams and oysters.
- Less than 300 parts per million can spoil the taste of fish.

4. Used oil thrown out in the garbage seeps through the landfill to contribute to leachate and contamination of groundwater.

- One quart of oil will foul the taste of 250,000 gallons of water.

5. Used oil can be re-refined into good-as-new lubricating oil. Oil never wears out, it just gets dirty.

- It takes 42 gallons of crude oil to produce 2 1/2 quarts of lubricating oil. But just one gallon of used oil can be re-refined into the same high quality 2 1/2 quarts of lubricating oil.

6. Used oil can be reprocessed into fuel oil, which contains about 140,000 BTUs of energy and can be burned efficiently.

7. To recycle use automotive oil, take it in a clean, sealed container such as a milk jug to the nearest participating recycling center or service station accepting uncontaminated used oil.

- Used oil should never be mixed with antifreeze, gasoline, paint thinner, solvents, cooking oil, or other contaminants since these interfere with reprocessing and may make the used oil a hazardous waste.

Adapted from ***A-WAY WITH WASTE, 1990 & CALIFORNIA STATE ENVIRONMENTAL EDUCATION GUIDE, 1988***

Little Jack Horner

Little Jack Horner
Sat in the corner,
Watching his father change oil,
He knew with some pain
If it went down the drain
The fish in the creek it would spoil.

Litle Jack Horner
Sat in the corner,
He suggested the fireplace instead.
His father said no,
The oil's dangerous so,
It might combust into lead.

Little Jack Horner
Sat in the corner,
"The garbage instead we could use!"
Sharp as a beagle
His dad said, "Not legal!"
"Our garbage service we could lose!"

Little Jack Horner
Sat in the corner,
Couldn't they bury it in dirt?
His father replied:
"Soil critters can't hide,
And many of them would be hurt."

Little Jack Horner
Sat in the corner,
Remembering his good friend Michael,
Who once had said
From his father's shed
Some substances they did recycle.

From ***SLEUTH,1982***

THE FOLLOWING ARE THREE ACTIVITIES ABOUT OIL AND ITS EFFECT ON THE ENVIRONMENT.

WHAT IS OIL REALLY LIKE?

PROCEDURE

1. Duplicate the attached three worksheets.

2. Explain that in this activity, the students will discover the properties of oil (what oil is like and what it does when it is used with other things). The students will do three experiments. Students will observe what oil does when it comes in contact with water, soil, and plants.

3. Divide the students into small groups. Each group gets the three worksheets to record their observations.

    1. oil with water
    2. oil with soil
    3. oil with plants

4. Have each group choose a recorder to write the observations. Students will proceed with the following steps:

    For the Oil With Water: Put several drops of oil in a glass of water. Describe what happens. Mix the oil in the water. Describe what happens.

    For the Oil With Soil: Put several drops of oil on the soil. Describe what happens.

    For the Oil With Plants: Put several drops of oil on the plant and describe what happens.

5. Write the summaries on a copy of the three worksheets and post them on the board. After a week, the Oil With Plants worksheet will be completed. Add those findings to the work sheets posted on the board.

Goals:
Students discover the properties of oil and see how it reacts when it is put in contact with other natural resources such as water, soil, and plants.

School Subject:
Science

Grades:
4th - 6th

Materials:
- Cooking oil in small containers
- Jars of water
- Ceramic bowls with soil in them
- Small plants in pots
- Student worksheets

Note: All activities are done with cooking oil to simulate motor or crude oil. Cooking oil can be cleaned up easier than motor oil; but the activities convey the concepts of oil-related problems.

Adapted from ***THE FOURTH R, 1985***

A. OIL WITH WATER

Put several drops of oil in a glass of water. Describe what happens. Mix the oil in the water. Describe what happens. Would you drink the water? Why or why not? Try to think of ways to get the oil out of the water. Can you remove the oil completely from the water?

B. OIL WITH SOIL

Put several drops of oil on the soil. Describe what happens. Is it possible to get the oil out of the soil?

C. OIL WITH PLANTS

Put several drops of oil on the plant and describe what happens. Check again in a few hours and a few days later.

OIL AND WATER DON'T MIX

PROCEDURE

Goals:
Students will learn how and why we recycle oil.

School Subject:
Science, Chemistry, Auto Shop.

Grades:
4th - 12th

Materials:
- A small container of cooking oil
- Red tempera poster paint (water based)
- One glass bowl
- One eye dropper
- One Funnel
- Very fine aquarium gravel or sand
- One quart or gallon jar
- One Measuring cup
- Water
- Small Screen

1. Familiarize the students with the information from "Oil in the Environment". Ask them the Discussion/Test Questions. Conduct the following demonstration with or for the students.

2. **Surface water**

Fill the glass bowl with water. Place several drops of oil on the surface. Note how the oil spreads across the surface in a thin film. Ask: What would happen to marine or fresh water surface organisms like plankton and insect larvae in this water? (Oil interferes with the life cycle of organisms which use the surface layer as a nursery ground.)

Ask: Can you get the oil out of the water?
Mix the solution. Ask: Could the oil and water be separated now?

Ask: Would you drink the water? Could fish thrive in this water? What would happen if the oil coated their gills? (They would suffocate.) If they absorbed or ingested the toxic contaminants in the oil? (They could develop skin or liver cancer.)

3. **Ground water**

Tell students that many people in the United States rely on groundwater for drinking. Groundwater is not usually in underground streams and lakes. It's usually stored in pores between rocks and gravel. These water bearing layers are called aquifers.

Put a small screen at the bottom of the funnel and pour in 1/2 cup of fine aquarium gravel or sand. Place the funnel over a jar. Measure out 1/2 cup of water and pour it into the gravel. Measure how much flows into the jar. Ask: Where is the rest of the water? (Held in the spaces between particles of gravel. This is how ground water is stored in aquifers.)

Say: When someone dumps dirty oil on the ground it can seep into this ground water. You can taste as little as one part per million. (1 ppm = 1 gallon of used oil in one million gallons of water or = 1 minute in the life of someone 12 years old.)

Drop two or three drops of red water based paint onto the water soaked gravel in the funnel. (Do not use oil based paints, they bond to the epoxy coating on some aquarium gravels.) Pour 1/2 cup of water through it (rainfall). Note how much oil or paint flushes through and how much remains in the gravel. Pour additional cupfuls of water over the gravel. Note how many volumes of water are needed to rinse the gravel clean. Ask: Would you want to drink this water?

4. **Ask:** How can we keep used oil out of surface and groundwater? (Used oil should be recycled.)

DISCUSSION/TEST QUESTIONS:

When you change the motor oil in your car, truck, motorcycle, or boat, what should you do with it? What should you not do with it? Why?

How much crude oil does it take to make 2 1/2 quarts of lubricating oil?

How large an oil slick can one pint of oil produce?

What is groundwater? What is the difference between surface water and groundwater?

Use automotive oil contributes____% to the total oil pollution of our nation's waterways? (over 40%)

Adapted from ***A-WAY WITH WASTE, 1990***

OIL SPILL

Goals:
Students conduct an experiment to observe the effects of oil, water, and detergent on bird feathers.

School Subject:
Science, Mathematics, Social Studies, Language Arts, Auto Shop.

Grades:
3rd - 12th

Materials:
- Feathers
- Cooking oil
- Water
- Dishwashing liquid detergent
- Several deep containers of water
- Several paper cups of oil
- Eye droppers
- Student activity worksheets for each pair of students
- One shallow container for each pair of students
- One hand lens for each student or group of students

PROCEDURE

1. Place water and oil separately into several different deep containers and position the containers so they will be easy for students to get to. Organize the remaining materials so they can be distributed quickly.

2. Tell students that they will be investigating some of the ways that one type of water pollution affects living things. Ask: What is an oil spill? Have you ever seen pictures of one? What causes an oil spill? What kinds of problems do you think an oil spill might cause?

Tell students that they are going to be looking at ways that pollution like oil affects wildlife. Divide the students into pairs. Distribute the student activity worksheets and briefly review it so that students know the lab activities they will be doing.

3. Supply each pair with an eyedropper, a small container of oil, and a shallow pan filled with water. Instruct students to add from one drop to a dropper full of cooking oil to their container. Have students observe the interaction of oil and water. Ask: What happens to the oil? Does it stay in one place?

   Have students record their observations on the worksheet, then dump the water into the sink.

4. Explain to students that they also will be observing how water, oil, and detergent affect feathers. Provide each pair of students with a natural feather. Demonstrate to students the steps they will take and have them work with their partners as follows:

First, students examine their feather with a hand lens and sketch or write about what they see on their worksheet.

Second, students dip the feather into water for one or two minutes. When they remove the feather they examine it again with the hand lens. Students then sketch or write about the feather and compare this observation with the previous one.

Third, students place the feather in oil for one or two minutes. When they remove the feather they examine it with the hand lens. Students sketch or write a new observation and compare with the other two.

Last, students clean the feather with detergent, rinse it in water, and dry it. They examine the feather with the hand lens, sketch or write and compare with previous observations.

5. Discuss all lab results.

Ask: What happened to the oil when it was placed on top of water? Did it stay in one place? How might the properties of oil affect wildlife? People? What changes did you observe after your feather was exposed to water? To oil? To detergents? What effect could these changes have on normal bird activity?

DISCUSSION/TEST QUESTIONS:

How else might birds be affected by an oil spill?

What other possible impacts might there be on other wildlife species, on humans, or on the environment?

Do we have to choose between oil and birds? What are some alternatives?

What are other examples of pollution that can have harmful effects for wildlife, people, and the environment?

Adapted from ***CALIFORNIA STATE ENVIRONMENTAL EDUCATION GUIDE, 1988***

AIR

BACKGROUND INFORMATION

The earth's lowest layer of the atmosphere, the troposphere, holds or carries water vapor, clouds, dust, smoke, soot, and a wide variety of chemical compounds.

Dry air is a relatively constant mixture of gases, around 78% nitrogen and nearly 21% oxygen. The final 1% is a mixture of carbon monoxide, carbon dioxide, nitrous oxide, methane, ammonia, and hydrogen sulfide, among others.

As air moves from one place to another, there often is an interaction between the various components of the fluid mixture. For example, water vapor will react with carbon dioxide to form carbonic acid. Sulfur and nitrogen oxides also take part in chemical reactions with water vapor, ozone, and other components leading to the formation of sulfuric and nitric acids. Sunlight sometimes plays an important role in these reactions. It is especially important in the complex chemical processes leading to the formation of ozone.

Only during the past 20 years or so have the people of the United States begun to understand that air is a resource that can be harmed by human activity and cause health and environmental quality problems. There are many sources of air pollution: motor vehicles, construction activities, pollen from plants, dust generated in the city and from agricultural activities, and thousands of vaporized chemicals, some of which are toxic and hazardous. We can influence the air quality by gaining control over emissions.

Pollution of the air by certain industrial processes, particularly the burning of coal, has been a concern for many years. Charles Dickens, in his book Hard Times, described in graphic detail the blackened air that hung over an English industrial town during the 1800s. However, it was not until thousands died because of air pollution, in such cities as London in the 1950s, that the first steps were taken to reduce the poisons that were routinely being emitted into the air we breathe.

Two major sources of harmful emissions became targets for initial action: utilities and industries, and motor vehicles. Steps were first taken to clean up smokestack emissions around power plants and industrial complexes. Attention was then focused on the sulfur oxides emitted from utility, commercial, and industrial stacks. At the same time, devices were developed to cut back on emissions from motor vehicles. It took years and money, but progress was made from the 1960s through the 1980s. The air is generally cleaner today than it was 30 years ago in much of the Nation.

Controlling air quality is a complex undertaking. An air mass is affected by many things as it moves across the earth. Plants, for instance, contribute oxygen as a by-product of photosynthesis. Oceans, lakes, streams, and vegetation contribute water vapor through evaporation and transpiration. In addition, the seas and marshlands contribute sulfur and a variety of salts. Volcanic eruptions can also throw tons of materials high into the atmosphere that remain in the upper air layers for several years, slowly making their way back to earth.

Other natural processes remove various materials from the atmosphere. For example, plants absorb carbon dioxide during photosynthesis, and both plants and animals use oxygen during respiration. Carbon dioxide is also absorbed by water. Rain also washes large amounts of particulate matter from the air. In short, a constant pattern of exchange occurs as air moves across the surface of the earth.

As the air moves, chemical changes are taking place. These changes can be beneficial, harmful, or of little or no consequence to the environment. Acid rain, for example, has become an issue of serious concern. Acid rain forms when water vapor combines with sulfur and nitrogen compounds to form acids.

Here are four major kinds of air pollutants:

Particulate matter: Particles in the air come from many sources: smokestacks and chimneys; cars and trucks, construction activities, agricultural and forestry operations. Most of the larger particles fall to the earth within a short distance of where they are generated. They are far less troublesome to human health than the tiny particles which remain in the air for long periods of time and can be inhaled deep into the lungs.

Sulfur dioxide: The largest source of sulfur dioxide are coal-fired power plants, industrial and commercial boilers burning coal or oil, cement plants, smelters, and petroleum refineries. Sulfur dioxide can cause damage to crops and natural vegetation. It also is associated with health problems for the very young and the elderly.

Nitrogen dioxide: This comes mainly from automobiles, large coal or oil-burning power plants, and industrial boilers. It also plays a role in the acid rain phenomenon.

Carbon monoxide: Motor vehicles produce this as a by-product of incomplete combustion. Too much carbon monoxide in our environment can affect the ability of blood to carry oxygen to the cells of our bodies.

Each year millions of dollars are spent to reduce the amount of pollution emitted into the atmosphere. Control devices such as electrostatic precipitators, scrubbers, and catalytic converters are already used to reduce emissions from smokestacks and automobile exhaust. However, tighter controls may be needed in the future.

Source: ***TVA: A WORLD OF RESOURCES, 1989***

AIR QUALITY GLOSSARY

Acid rain: sulfur dioxide from industrial and power facilities and nitrogen dioxide from auto emissions mixes with other elements of the atmosphere to form an acid which returns to earth's surface as rain.

Asbestos: fibrous form of impure magnesium silicate that is used for electrical insulation, fire proofing, and brake linings.

Benzene: a clear, colorless, flammable liquid that is used to manufacture DDT, detergents, insecticides, and motor fuels.

Carbon Dioxide (CO2): A colorless, odorless gas that is formed during respiration, combustion, and organic decomposition. It is used commercially in carbonated beverages, fire extinguishers, and aerosols.

Carbon Monoxide (CO): A colorless, odorless toxic gas given off during incomplete combustion, primarily from motor vehicles.

Chlorofluorocarbons (CFCs): These are certain chlorine and halogenated hydrocarbons such as refrigerants. These compounds, when exposed to ultraviolet light, release chlorine, which then acts as a catalyst to destroy ozone in the upper atmosphere.

Clean Air Act: An environmental law enacted by Congress and enforced by the EPA which sets air quality standards.

Emergency Planning and Community Right to Know Act: An environmental law enacted by Congress and enforced by the EPA that gives citizens access to information about the transportation and use of hazardous materials in or through their community.

Fluorides: Very reactive, pungent, colorless gasses such as hydrogen fluoride (HF), which can cause plants to develop yellow leaf tips and margins (chlorosis).

Hydrocarbons: compounds that contain hydrogen and carbon. Found in gasoline and petrochemicals.

Hydrogen sulfide: a colorless gas with a very offensive "rotten egg" odor. It is produced during combustion and natural decomposition (sewer gases). It tarnishes metals and blackens paints. In high concentrations, it can cause asphyxiation.

Lead: an element emitted into the atmosphere by lead smelters and the burning of coal and leaded gasoline. When lead is inhaled, it can be carried into the bloodstream and cause lead poisoning.

Ozone (O3): a gas with a sweetish odor occurring in the upper atmosphere that protects the earth from the harmful ultraviolet rays of the sun.

Ozone hole: an opening in or depletion of, the ozone layer in the upper portion of the earth's atmosphere which filters out cancer causing ultraviolet radiation from the sun. CFCs are the main chemical involved in this process.

Particulates: solid particles or liquid droplets including fumes, smoke, dusts, and aerosols.

Smog: photochemical haze produced by the action of the sun and atmosphere on automobile and industrial exhaust.

Troposphere: the innermost layer of the atmosphere, which contains about 95% of the earth's air and extends about 8 to 12 kilometers (5-7 miles) above the earth's surface.

Ultraviolet radiation (UV): a type of light ray emitted from the sun (and other sources) that in large doses can cause sunburn and is linked to skin cancer.

BROWN AIR

(the song)

Chant:

A7 aug9 A
Brown Air! Brown Air! Yuk!
Brown Air! Brown Air! Yuk!

G A G A
I'm a loose and leafy lettuce plant (a loose and leafy lettuce plant)

G A G A
I love to grow but sometimes I can't (a loose and leafy lettuce plant)

G A G A
You see I live right by the street (a loose and leafy lettuce plant)

G A G A
And car smoke makes me really beat (a loose and leafy lettuce plant)

Chorus:

D E A D E A
Brown Air, Brown Air...It makes you cough and it makes you choke

D E A E E7 E
Good Air, Clean Air...Is air that's clean and free from smoke

D E A D E A
Brown Air, Brown Air...Sometimes you can't even see it

D E A D E A
But Good Air, Clean Air...You know it's safe to breathe it...

(Chant)

I'm a green and growing maple tree (a green and growing maple tree)
And I like rain, but you know it's killing me (a green and growing maple tree)
When it hits me I feel pain (a green and growing maple tree)
Cause air pollution makes acid rain (a green and growing maple tree)

(Chorus/Chant)

I'm a hip and hopin' human being (a hip and hopin' human being)
And I don't like some things I'm seeing (a hip and hopin' human being)
Well dirty air is just no fun (a hip and hopin' human being)

© Mike Levy, ***ADVENTURES IN THE AIR CYCLE, 1988,*** Banana Slug String Band

ACID RAIN

BACKGROUND INFORMATION

The pH scale goes between 0 on the acidic end, to 14.0 on the basic or alkaline end. 7.0 is neutral. Normal rainfall has a pH of 5.6. It is naturally acidic because the reaction between carbon dioxide and water in the atmosphere produces carbonic acid. Precipitation is referred to as acid rain when the pH falls below 5.6.

The two main culprits in acid rain formation are:

1) sulfur dioxide (SO2), from smelters or coal-burning power plants
2) nitrogen oxide (NOx), mainly from vehicle exhaust

In the atmosphere these gases oxidize to form sulfate or nitrate particles. When these particles combine with water vapor they form sulfuric acid or nitric acid. These acids become part of the water cycle and return to earth in precipitation or as dry deposits. In addition to falling directly on bodies of water, acid rain falls on soils surrounding a lake or stream (the watershed). The acids and heavy metals accompanying them are then stored in the soil and released into lakes when precipitation runs off the land into the water.

The acid-forming compounds come from natural as well as human-made sources. A volcanic eruption can cause acidic conditions covering half the globe. Decay processes involving both plant and animal materials, which occur in marshes, swamps, and oceans, can also produce chemicals that can increase acidic deposits. Many researchers, however, believe that a major source of increased acid in rainfall is industrial activity such as the burning of fossil fuels like coal, gasoline, fuel oil, and natural gas.

The majority view is that air pollutants in acid rain are responsible for creating acid conditions in lakes and streams, particularly in the eastern United States, Canada, and Scandinavia.

Some of the impacts attributed to acid rain are:

- The balance of life in an aquatic community is disrupted by acid rain. Not only fish are affected; other aquatic and terrestrial animals, including microscopic organisms, can be harmed as well.

- Lakes and ponds in some areas are becoming lifeless as the water becomes too acidic to support life. Small amounts of acid can affect the reproductive ability of fish.

- Acid rain is more than just acidic water. Heavy metals, including lead, cadmium, and mercury are also found in acid rain. These metals are dissolved by the acid and end up in the bodies of fish. When we consume the fish we consume the metals.

- Heavy metals and acids in rain cause damage to vegetation and reduce soil fertility. This is having a negative impact on some crops and forested areas.

- Our drinking water supplies can be affected by acid rain. Lead and copper can be leached from watershed soils or from pipes supplying our water and contaminate it.

- Sulfate and nitrate particles are extremely small, and when inhaled can cause serious respiratory problems.

- Acid rain contributes to the deterioration of art objects, monuments, and buildings causing us to spend an estimated $2 billion each year in the United States for repairs.

Sources: ***LIVING LIGHTLY ON THE PLANET, 1987 and TVA: A WORLD OF RESOURCES, 1989***

THE NOT SO GENTLE RAIN

BACKGROUND

See Acid Rain Background Information.

PROCEDURE

1. Use Transparency A to explain pH values. The acidity or alkalinity of water and other liquids is measured according to a pH scale which ranges from 0-14. Distilled water has pH of 7.0, which is considered neutral. Readings above pH 7.0 are alkaline, and below 7.0 are acidic. The scale is a base-10 logarithmic progression which means that a solution with a pH of 4.0 is ten times as acidic as a solution with a pH of 5.0, and 100 times as acidic as a solution with a pH of 6.0. Therefore, the lower the pH number, the stronger the acidity; the higher the pH number, the stronger the alkalinity. Theoretically, rain water is naturally slightly acidic with a pH of 5.7.

2. Divide students into groups so they can test the pH of various acid and base solutions using the pH test kit. Students can test common household substances such as vinegar, ammonia, cranberry juice, lemon juice, baking soda solution, milk of magnesia, tap water, distilled water, and soft drinks.

3. Record the pH of each solution on Student Worksheet #1. Later, when local rain water has been collected and the pH tested, add the results to this chart.

4. Record group results on Transparency B. Discuss what effect these substances would have if they were absorbed by plants, ingested by animals, or collected in lakes or rivers.

5. A waste or material is corrosive and hazardous if it has a pH less than or equal to 2 or greater than or equal to 12.5. Have the students discuss this in relation to the substances they have tested. What businesses might have solutions and wastes that would be "hazardous"? (For example: plating industries, electronic goods manufacturers, cosmetic manufacturers, pulp mills, etc.)

Goal:
Students will:
- Understand the relationship of the pH scale to acidity and alkalinity.
- Discuss the sources and problems of acid rain.
- Measure the acidity of local rainfall.

School Subjects:
Mathematics, Language Arts, Social Science, Science.

Grades:
6th – 12th

Time:
Five class periods.

Materials:
- A local map
- Glass containers (test tubes if available)
- pH test kit
- Tweezers
- Water samples from rain, local streams, ponds, etc.
- Two student worksheets for each student
- 3 transparencies

6. Wash all the wide-mouthed jars with distilled water, if possible, then cap all of them until they are to be used.

7. Use a map of your area to pick sites at which students or groups of students will sample rain water. Try to sample as much of the area as possible.

8. Sampling will have to be done outside of class because of the area the sample will cover.

WHEN IT RAINS

Students go to their assigned sites with their containers. They should open the containers and place them in open areas where rain can fall directly into them. When they have collected approximately one centimeter of water, they should cap the jars tightly and keep them capped until they are ready to test the pH of the rainwater in class. Have students record the direction of the wind before and during the rain.

9. Each group of students may record its data using the worksheet included with the activity.

10. In class, give each group one piece of pH paper, a pair of tweezers, and a small test tube with a stopper. Each group should:

    a. use the tweezers to put the pH paper in the test tube

    b. add the rainwater, stopper the test tube, and shake the sample for 60 seconds

    c. compare the color produced by the rainwater sample with a pH color key card or scale.

11. Students could color code a map of the area showing sample sites and the pH of the rain at each location.

12. Record results of local rainfall pH on Transparency C.

DISCUSSION/TEST QUESTIONS

Was the average pH of the rainwater in your community higher or lower than 5.7? If it was lower than 5.7, what could be causing its acidity?

Was the pH of the rainwater the same throughout your community?

How does the pH compare from one location to another?

From what direction was the wind blowing before and during the rain? What bearing might that have on the results of the study? If rainwater is naturally acidic, what kinds of things that are not caused by man might contribute to that acidity?

What are some possible effects of excess acidity in rain?

Who or what are sources of man-made acidity in rainwater?

Where are the greatest concentrations of these sources in the United States? In the world?

Where in the United States, in North America, and in the world are the effects of acid rain being felt?

How serious are those effects? Why is acid rain considered a problem?

What kind of technology (if any) exists for controlling this problem?

How does this acidity seem to be transported from one area to another?

Who do the experts and the general public hold responsible for acid rain?

Is action being taken to correct the problem? Do you think the action attacks the problem's source effectively?

Adapted from ***THE CLASS PROJECT, 1984 and the CALIFORNIA CLASS PROJECT, 1988***

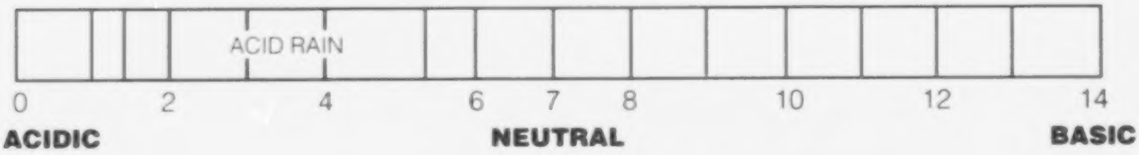
pH Ratings of Various Liquids

Student Worksheet #1 **Name** ____________________

1. Complete column A by predicting whether each liquid is acidic or basic.
2. Test each liquid with a pH test kit. Complete the chart below.

Liquid	**Column A** Predicted results: Acid, Neutral, or Basic	**Column B** Actual pH	**Column C** Acidic, Neutral, or Basic
Ammonia			
Baking Soda Solution			
Distilled Water			
Lemon Juice			
Milk			
Milk of Magnesia			
Oven Cleaner			
Saliva			
Shampoo			
Tap Water			
Vinegar			
Other			
Rain Water			

3. Plot and label the pH of each liquid on the graph.



pH of Your Local Rain

Student Worksheet #2

Name ______________________

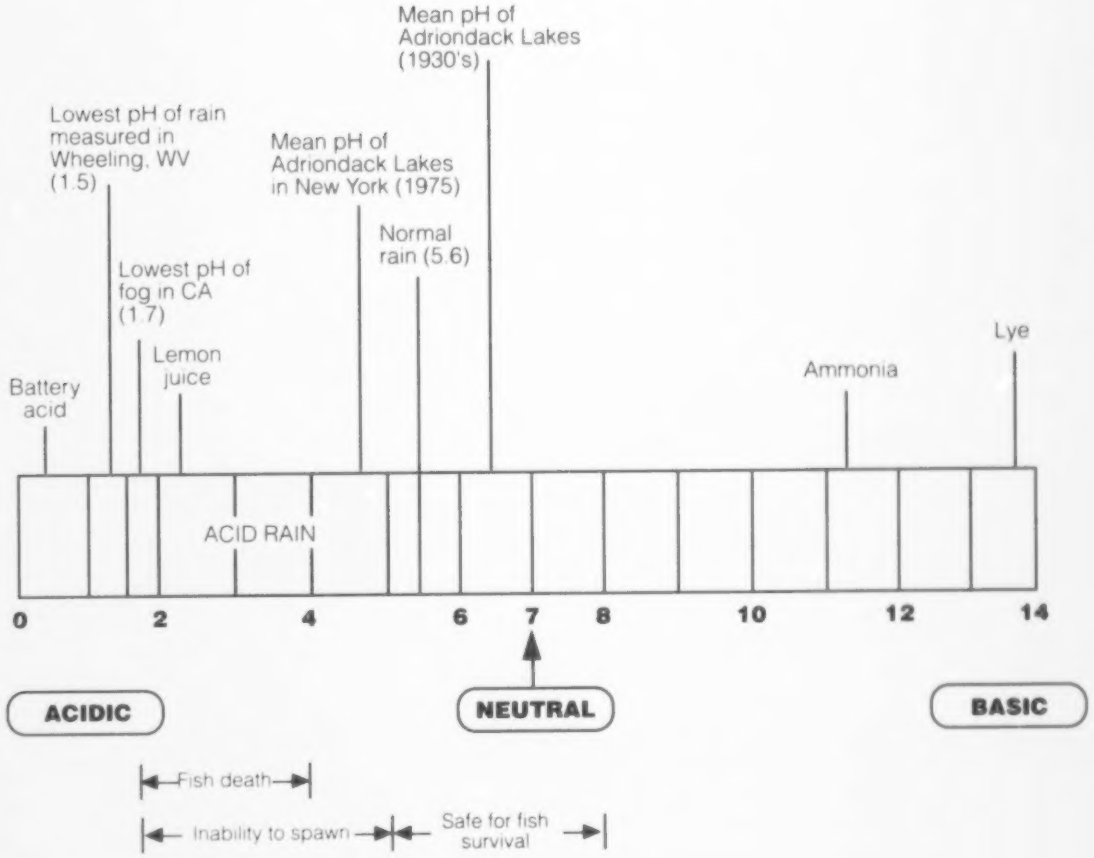
Use this worksheet to record data at your rain collection site. Information requested in questions 6 and 7 should reflect the conditions during the rainstorm. This can be obtained from the weather bureau, local newspapers, or TV weather reports.

- Location of test site #1 ______________________
- Date ______________________ Time ______________________
- Site description (vegetation and physical appearance of your test site, including any buildings.)
  ____
- Time rain began ______________________ Time rain stopped ______________________
- Period of time during which sample was being taken ______________________
- Total period of rainfall ______________________
- Intensity of the rain (downpour, medium, light, mist) ______________________
- Wind direction ______________________
- Wind speed ______________________
- When you return to class, test the pH of your rain sample. pH of rain sample was:
  ____

- Location of test site #2 ______________________
- Date ______________________ Time ______________________
- Site description (vegetation and physical appearance of your test site, including any buildings.)
  ____
- Time rain began ______________________ Time rain stopped ______________________
- Period of time during which sample was being taken ______________________
- Total period of rainfall ______________________
- Intensity of the rain (downpour, medium, light, mist) ______________________
- Wind direction ______________________
- Wind speed ______________________
- When you return to class, test the pH of your rain sample. pH of rain sample was:
  ____

pH of Your Local Rain

Transparency A


Mean pH of Adriondack Lakes (1930's)
Lowest pH of rain measured in Wheeling, WV (1.5)
Mean pH of Adriondack Lakes in New York (1975)
Normal rain (5.6)
Lowest pH of fog in CA (1.7)
Lemon juice
Battery acid
Ammonia
Lye
ACID RAIN
0
2
4
6
7
8
10
12
14
ACIDIC
NEUTRAL
BASIC
Fish death
Inability to spawn
Safe for fish survival

Summary of the pH Rating of Various Liquids

Transparency B

ITEM	GROUP pH READINGS	AVERAGE READINGS	ACID/NEUTRAL/ BASE
Ammonia			
Baking Soda Solution			
Distilled Water			
Lemon Juice			
Milk			
Milk of Magnesia			
Oven Cleaner			
Saliva			
Shampoo			
Tap Water			
Vinegar			
Other			
RAIN WATER			

Summary of the pH of Local Rain

Transparency C

SAMPLE NUMBER	LOCATION	WIND DIRECTION/ SPEED	pH
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
		COMMUNITY AVERAGE	

SULFUR DIOXIDE DANGERS

BACKGROUND

Review the Acid Rain background information. Sulfur dioxide, besides having a noxious smell, can interfere with photosynthesis. In this demonstration, there will be a high concentration of sulfur dioxide gas in a closed bag. Because the amount of gas in the bag will be high, effects to the plant will be immediate and severe. It is suggested that the teacher should do this activity as a demonstration only!

PROCEDURE

1. Take the class outside for this demonstration. Wearing safety goggles, place 2 gm of sodium nitrate in the small beaker and place the beaker and the potted plant inside the plastic bag. Add 2 ml of 5% sulfuric acid to the small beaker and seal the bag shut with the tape. If sulfur dioxide gas leaks from the bag (has a very sharp odor), move the class away until the reaction is completed. Leave the plant in the closed bag at least 10 minutes. Cut the bag open and allow the gas to disperse. After the plant has aired out, take it back to the classroom. Be sure to wash your hands.

2. Allow the class to observe the plant for 2 days and keep a log of their observations. Ask them to note color, leaves, and general health. Provide a second, similar plant for comparison. Discuss with the students why sulfur dioxide emissions are regulated to stay below certain levels. Explain that the demonstration used a high concentration of sulfur dioxide, but under natural conditions, the deterioration of the plant would take more time such as weeks or months.

Goal:
Students will observe the effects of sulfur dioxide on plant life.

School Subjects:
Biology, Chemistry.

Grades:
9th - 12th

Time:
One class period, a few minutes for several days for additional observations.

Materials:
- Tape
- Large clear plastic bag
- Two green potted plants
- Small beaker
- Sodium suilfite (2 gm)
- Sulfuric acid (5%), (2ml)
- Safety glasses

DISCUSSION/TEST QUESTIONS

Where does sulfur dioxide come from? Are there natural sources? How is sulfur dioxide related to acid rain? What can be done to reduce sulfur dioxide emissions?

Adapted from ***TVA: A WORLD OF RESOURCES, 1989***

MONITORING PARTICLES IN THE AIR

Goal:
Through sample collecting, students identify air particles and compare the kind and number of particles found in different locations.

School Subjects:
Science, Mathematics.

Grades:
3rd - 6th

Time:
Two 30 minute periods, four or more days apart.

Materials:
- Petroleum jelly
- Tape
- Paper towels
- String
- Hole punch
- Two 5cm (2 inches) squares of waxed paper for each student
- Two 5cm(2 inches) squares of cardboard for each student
- Hand lens for each student

BACKGROUND

Particles in the air can be harmful because they get into lungs, make things dirty, and coat plants so that it may be difficult for them to grow. Air pollution has harmed trees in forests near most cities.

Most air pollution is caused by burning something. Major sources of air contaminants are automobiles, airplanes, industrial plants (like cement factories, steel mills, and chemical processors), electric power generators, heating systems (of homes, offices, factories, and schools), and pesticides.

PROCEDURE

1. Remind students that air is a basic necessity for most life. Ask: Do you think air moves from place to place? How do you know? How can you observe air moving?

2. Students can see air moving dust particles in a stream of light or feel air moving when they blow on their hands. Ask: Do you think the air we are breathing has been somewhere else? Do you think it will travel far away after it's been here? If there is something harmful in the air, does it stay in one place? Tell students that they will be collecting particles in the air to find out more about air movement and air pollution.
3. Demonstrate to students how to make a "sticky square", which they will use to sample dirt and dust particles. First, have students label a cardboard square with their name and tape the waxed paper square to the cardboard. Next, cover the waxed paper with an even coat of petroleum jelly (a messy process). Finally, place the square in a place where it will be undisturbed for a week.

4. Help students place their "sticky squares" so that the squares are distributed among a variety of places both inside and outside the classroom. Students can also tie a piece of

string through punched holes and hang the squares.

5. At the end of a week examine the squares with a hand lens or magnifying glass. Count the number of particles collected on each square. Compare different particles on each square. Compare differences depending on the location of the squares.

DISCUSSION QUESTIONS:

Which places had the most particles?

Which places had the fewest particles?

What do you think the particles are?

Do all of the particles look the same?

Where do you think the particles came from?

How might the particles be harmful? If something harmful gets into the air, does it stay in one place?

Are there any natural causes for things in the air?

Are there ways we could cut down on the number of particles in the air?

Adapted from **CALIFORNIA STATE ENVIRONMENTAL EDUCATION GUIDE, 1988**

SOLID WASTE

BACKGROUND INFORMATION

Solid waste is any unwanted or discarded material that is not a liquid or a gas. This includes yesterday's newspaper and junk mail, today's dinner table scraps, raked leaves and grass clippings, nonreturnable bottles and cans, worn-out appliances and furniture, abandoned cars, animal manure, crop residues, food-processing wastes, sewage sludge, fly ash, mining and industrial wastes, and an array of other cast-off materials.

The total amount of solid waste from all sources produced each year in the United States is staggering — estimated to be at least 5.1 billion tons. This amounts to an average of 21 tons a year per capita, or 115 pounds a day. About 89% of this solid waste is produced as a result of agricultural and mining activities. Fortunately, over 90% of agricultural solid waste is recycled into the soil by being plowed under or used as fertilizer (manure and some crop residues).

Industrial solid waste makes up about 8% of the total produced each year. Much of this is scrap metal, plastics, slag, paper, fly ash from electrical power plants, and sludge from sewage treatment plants.

Solid municipal waste produced by homes and businesses in or near urban areas makes up the remaining 3% of the solid waste produced in the United States. Each American produces an average of about 4 pounds of garbage per day, or 1,460 pounds per year. The typical American garbage consists of: 40% paper, 17% food, 13% yard waste, and the remaining 30% is glass, plastics, metals, wood and other wastes.

Sources: ***A-WAY WITH WASTE, 1985, WASTE: A HIDDEN RESOURCE, 1988, and ENVIRONMENTAL SCIENCE, 1988***

BEST COPY AVAILABLE

Where Is Away?

Chorus:

G G
Where is away? (leader) Where is away (group echoes)

G
Well it's over there (leader) Well it's over there (group echoes)

C C
Where is away? (leader) Where is away? (group echoes)

C C
Yea, it's over there (leader) Yea, it's over there (group echoes)

D7 D7 C# 7 C7
There's no away (leader) There's no away (group echoes)

Ya gotta throw it somewhere (leader) Ya gotta throw it somewhere (group echoes)

F# G
Well, I took a little trip about a thousand miles,

B9 C9
Get away from the garbage piles

G# A
I went walking out on the beach

D# 9 D9
But the broken glass cut my feet

***Chorus:* (Replace last line with) Ya gotta put it somewhere**

I went sailing out on the high seas,
To feel the fresh ocean breeze.
Nothing but sky and sea all around
Then I ran into an oil slick, it really brought me down

***Chorus:* (Replace last line with) Ya gotta dump it somewhere**

I went backpacking in the high Sierra.
Get some of that clean mountain air.
Get away from that old city rat race,
Right then I stepped in someone else's waste.

***Chorus:* (Replace last line with) Ya gotta leave it somewhere**

by Mark Nolan

From ***SONGS FOR THE EARTH, BANANA SLUG STRING BAND, 1985***

BE A GARBAGE DETECTIVE

PROCEDURE

1. Ask each student to draw two pictures. One picture should be of his/her house. The other should be of a deer's, bear's, or snake's "house". Ask students to look at their pictures and think about garbage. What is garbage? Do animals have to deal with garbage? What kind of garbage do people produce? What kind of garbage do animals produce? Why do people have so much more garbage than animals? How do people get rid of garbage? Where does it go? What happens to it after it gets to the landfill?

2. Working together, with the teacher taking dictation and writing on the chalk board, have the class create a story describing the pictures they have drawn.

3. Have the children go through magazines and find pictures of things that often get thrown away after only one use. Have the children create a poster from these pictures.

   Ask: How could we avoid throwing away so many of these things?

4. Display drawings, the class story, and poster.

Goals:
Students will define waste (what we often call garbage) and become aware of what happens to it after it is put in the trash can.

School Subject:
Art, Science, Language Arts

Grades:
K - 1st

Time:
One class period.

Adapted from ***A-WAY WITH WASTE, 1985***

NOWHERE IS AWAY

Goals:
Students will learn what each can do to help solve the problem of too much solid waste.

School Subject:
Social Studies, Mathematics

Grades:
3rd - 8th

Time:
1 - 2 class periods

Materials:
- 4 1/2 pounds (2 kilograms) of trash
- Pictures and articles about the solid waste problem

PROCEDURE

1. Bring to class a 4 1/2 pound bag of garbage, or bring in a school garbage can.

2. Emphasize that, on the average, each person in the United States discards about 4 1/2 pounds of waste a day.

3. Using these figures, how many tons of garbage would this class generate in a year? To gain a clearer understanding of the magnitude of a ton, have students add the weights of class members until a ton is reached.

4. Ask: Where does all this waste go? What problems does it create?

5. Show pictures of landfills. Identify local landfills. Tell students that, nationally, most waste goes into 15,000 landfills occupying 467,000 acres. (One acre is about 1.5 times the size of a football field.) Calculate: How many football fields are covered with trash? Emphasize that at the increasing rate at which we are throwing away trash, we need approximately 500 new dumping locations every year. Other problems associated with this growing mountain of trash are:

   - finding sites for landfills is becoming increasingly difficult
   - runoff and leachate from landfills pollute surface and groundwater
   - disposing of waste is very expensive (about $4 billion a year is paid by Americans to dispose of trash)

6. Ask: What can you and I do to help solve this problem? Brainstorm possible solutions. Emphasize that one important solution is to generate less waste. Discuss what kinds of waste students generate and discuss ways to reduce it.

7. Emphasize that another solution is to recycle. Using articles from the 4 1/2 pound bag of trash, have students suggest which can be recycled, and sort the bag.

Adapted from ***A-WAY WITH WASTE, 1985***

WHAT IS GARBAGE TO YOU MAY BE GORGEOUS TO ME

PROCEDURE

Goals:
Students will understand that one good answer to the problem of solid waste is to extend the life of what they own by finding new uses for it.

School Subject:
Social Studies, Creative Thinking, Language Arts

Grades:
K - 6th

Time:
2 - 4 class periods

Materials:
- 4 1/2 pounds (2 kilograms) of trash

1. Using the same 4 1/2 pound (2 kilogram) bag of garbage used in "Nowhere is Away", ask students for help in thinking of ways that the various articles and materials could be used again.
2. As each article is handled, discuss the difficulties of its disposal. For example, ask, "What happens to this plastic milk jug or wrapper or glass jar or stale bread when it is "thrown away"; when it is buried; when it is burned? What problems are caused by burying and burning these things?"
3. As each article is handled, discuss how we might either avoid buying it in the first place or buy something comparable that would be easier to recycle, reuse, or compost.
4. Have each student bring from home an article of "garbage" with potential for reuse. Have each explain, either orally or in writing, how each article could be reused.
5. Make a class booklet of the best ideas. Make copies of the booklet to be included in a take-home recycling kit, page 151.

DISCUSSION/TEST QUESTIONS

Name three things that you have thrown away that could have been reused.

Why is reuse important?

Adapted from ***A-WAY WITH WASTE, 1985***

THE THROWAWAY THREE

Goals:
Students will become aware that historical methods of getting rid of solid waste (throw it, bury it, or burn it) won't solve modern urban garbage problems.

School Subject:
Social Studies, Language Arts, Drama, History.

Grades:
4th - 6th

Time:
2 class periods

Materials:
- Skit script, props (see below)

PROCEDURE

Prepare materials as described in the skit script on the following pages. Encourage students to make props and costumes from recycled or reused materials. Work with students to develop a production which could be performed for other classes, for parents, or for a group in the community.

Pre-Performance Suggestions:

The central idea is that as the skit progresses, each person throws more trash on the pile in the middle of the room so that a high stack is created. The skit suggests that one way to solve the problem is to recycle. Following the performance, discuss ways to solve the problem of too much garbage and trash.

Props:

- Monkey: monkey masks, banana peel
- Cave Dweller: skins
- Roman: Roman helmet, bag of trash
- Briton: stack of trash
- Settlers: Pilgrim hat
- Colonist: coonskin hat, leather
- Industrialist: engineer's cap, 3 sweaters (1 hand made, 2 machine-made)
- Scientist: lab coat
- also: nylon stockings, plastic bags and containers, perma-pressed shirt, TV dinner, broken small appliance, toy car, Indian headband, old blanket and cola bottle, orange peels, clear bottle, flower.

Post-Performance Discussion:

The skit shows students that people have historically gotten rid of solid waste successfully by throwing it out, burying it, or burning it. But none of these methods solves modern urban garbage problems. The discussion should attempt to reinforce this concept. One way this can be done is to discuss the characters in the skit: how they disposed of their garbage or trash and why their method of doing so was either satisfactory or not satisfactory.

Monkey: Threw it down. No problem developed because no large concentration of monkeys existed.

Cave dweller: Threw it, burned it, buried it. These acts still did not cause a problem for the same reasons.

Roman: Threw it. Tossing out garbage began to be a problem because of the many people who lived in cities, but it was easily solved by taking the garbage out of the city.

Briton: Threw it. A problem grew because more and more people moved to the cities, thus producing more trash than they could get rid of in the city.

Settler: Had virtually no garbage.

Colonist: Threw it, burned it, buried it. With greater trade came more things to be discarded.

Industrialist: With a greater concentration of people in cities than ever before, and more buying because machine-made goods were cheaper, much more was thrown out.

Scientist: The big change to synthetics plus the use of enormous amounts of natural resources are causing tremendous problems.

Adapted from ***A-WAY WITH WASTE, 1985***

THE THROWAWAY THREE
(script)

Person 1

Props

This is the tale of the Throwaway Three. Of Man and his Garbage throughout history:
Now they're very nice people, just like you and me.
Who all have a problem, as you will soon see
What shall they do with their garbage and trash?

All

Why, throw it! Or bury it! Or burn it to ash!

Person 2 - Monkey (90,000 BC)

I represent primates who lived in a tree.
I get rid of garbage so easily!
It's a snap! It's no problem - to me or to him.
We just let go, plop! Down through the limbs.

Monkey mask
Banana peel

Person 3 - Cave Dweller (50,000 BC)

I am a cave dweller who lives on the ground.
What do I do with old stuff all around?
Why, burn it, like meat: burn it up in the fire: Or bury it like bones, in the muck and the mire.

Skins

All

Yes, throw it, or bury it, or burn it to ash!
That's how we always get rid of our trash!

Person 1 - Roman (200 BC)

I am a Roman who lives in the town.
Our laws won't allow me to just throw it down. I have to drag it away for a mile.
And then I can dump it, forget it, and smile!

Roman helmet
Bag of trash

Person 2 - Briton (1200 AD)

I am a Briton, wary and quick;
Down on our street it can get pretty thick.
When housewives up there want to pitch out their goo.They just heave it out there and yell:
"Gardy-loo!" (Person 1 stands on chair and yells, "Gardy-loo!")
It will stay there and stay there until the next rain,
Or until our fair London should burn down again.

Stack of trash

All ***Props***

Oh, what do we do with our garbage and trash:
We throw it, or bury it, or burn it to ash!

Person 3 - Settler (1630)

Pilgrim hat

I am the settler. I came without much,
But everything else I must make with my hands.
So I don't throw out much — I use all I can.
Cloth scraps become quilts; I reuse my bent nails
It will be a long time 'fore the next trade ship sails.

Person 1 - Colonist (1700)

Coonskin hat
Leather

I am a colonist; now life's not so tough.
We have trade between cities that brings lots of stuff.
And some things are made by our townfolk today.
I could buy a new harness, throw this old one away.
We have pigs and hogs running loose in our street,
If I toss it out there, they'll eat it up neat!

Or I might bury it right over there. Or I might burn it; nobody would care.
You see; the New World is the same as the Old!
We trashmakers come from the time-honored mold.

All

What are we still doing with garbage and trash?
You guessed it!
Throw it away, or bury it, or burn it to ash!

Person 2 - Industrialist (1890)

Engineer's cap
3 sweaters
(one handmade,
two machine made)

I'm the industrial person and new on the scene,
I mass-produce goods with my trusty machine.
This sweater, handmade, took a week in days of yore,
But now in one hour, I can make forty-four.
I make things so cheaply, you can now afford two.
And throw out twice as much trash as you need to do.

Person 3 - Scientist (1950)

Lab coat

I am the scientific person in the new post-war age.
We've learned a few tricks while the war shortage raged.
When we couldn't get natural stuff to process,
We invented synthetics to replace the rest.

	Props
Person 2 - Industrialist	
Rayons and nylons, acrylics and plastics, For furniture and clothing and even elastics; Forget your old woolens and silks and your cotton; Real wooden toys and washboards are forgotten.	Nylon stockings Plastic bags & Containers
Person 3 - Scientist	
Our new stuff will last 'til forever, you see Even when it's worn out to you and to me. Permanent press, pre-sized and pre-shrunk; When dingy and old, it's still permanent "junk" (Person 1 yells "Junk")	Perma-pressed shirt
Person 2 - Industrialist	
We make instant menus that come in a "pack". You just boil the food in its own plastic sack Or our TV dinner in its tinfoil tray It's quick; you don't wash it; just throw it away!	Plastic bag TV dinner
Person 3 - Scientist	
We make lots of TVs and clothes dryers, too Don't ask for a trade-in; you're kidding, aren't you?	Broken small appliance
Person 2 - Industrialist	
Our new cars all change with each model year, Don't try to repair them, the cost's much too dear. Besides, we don't bother to make last year's parts for Skylarks or Novas, or Cougars, or Darts.	Toy car
Person 3 - Scientist	
It's the New Thing, the NEW that American craves. So out, out with the old stuff, away to its graves.	
Person 2 - Industrialist	
So what if there's more of us buying more goods? So what if they won't rot away as they should?	

Person 1 - Indian

Props

Now wait just a minute!
You cannot fail to include me in your historic trash tale.
We Indians lived simply, on prairies, in woods.
We made no high trash piles, nor mass-produced goods.
Let me be your critic, show you where you stand.
And tell you just how you're defiling our land.
Your new-fangled goods will not rot away.
When you throw them all down they remain there they lay.
Then you say you will bury them deep in the ground:
All your urban trash will make quite a mound!
So then you would burn it, in smoldering masses
and fill up our air with smoke, deadly gases!
Oh, all of your answers have faults everywhere:
You'll either ruin the water, the land, or the air.
What's more, your resources—your lumber, your ore—
Get smaller each year than the year before.
And what's more—this old earth's not making any more!

Indian headband

Person 2 - Industrialist

You're right.
Our resources are shrinking away while our garbage problem grows bigger each day.
We're always converting resources to refuse
Instead of recycling them for reuse!

Throw out
old blanket
and Cola bottle

Person 3 - Scientist

Oh stop it! Don't drop it!
We'll think of a way to make food for cows that's much better than hay.
Don't burn it, return it—we'll make something new.
A vase for your mother, a spyglass for you.
Don't bury it, carry it—back to the mill.
We'll make a new blanket to ward off the chill.

Flower in bottle for vase
Bottle held up to
eye for spyglass

Pick up old blanket and
wrap around shoulders

Person 2 - Industrialist

It's time we progress past the Disposal Age
and make recycling the popular rage!
We'll have to give up old solutions for trash
and all realize that it's pure balderdash - to just

Pick up
Orange peels
Clear bottle
Flower

All

Throw it, or bury it, or burn it to ash!

CONSEQUENCES OF LITTER

Goals:
Students express the emotional impact of environmental damage.

School Subject:
Social Studies, Language arts, Arts, Science.

Grades:
3rd - 6th

Time:
30 - 45 minutes.

Materials:
- Drawing paper, crayons

BACKGROUND

In this activity students look at how consequences of people's actions toward the land can affect other people.

The guided imagery in this activity enables students to begin to understand that everyone has a special place he or she is emotionally attached to. This emotional attachment is the reason people get so upset over environmental issues. Guided imagery is a good way to allow students to use their imaginations; it also enables students to go on imaginary journeys even if they are unable to take real ones.

PROCEDURE

1. Take your students on a guided imagery journey of a special place. "Close your eyes and think of a place that is special to you...it might be in your backyard or a place you go on vacation every year...it is a place where you can think and where you enjoy being...think about the smells of that place, the sounds you might hear, the things you see around you...now imagine that while you are in your special place, someone walks by and throws an empty soft drink can on the ground...imagine how you feel...now imagine that someone else walks by and throws a bunch of hamburger wrappers and empty milkshake cups on the ground...imagine that you don't move from where you are, but think about how you feel...now imagine that someone comes by your special place and empties a huge garbage can full of garbage right in the middle of your special place so that there is a huge pile of trash in your special place...imagine how you feel...think about how your special place looks now and remember what you see and feel...when you are ready, open your eyes."

2. Distribute pieces of drawing paper and crayons or marking pens. Instruct students to draw a line down the middle of their paper. Have students draw two pictures. On one half of the paper a picture of their special place before the litter and on the other half a picture that includes the litter.

3. Discuss with students what they experience in their guided imagery. Ask volunteers to share their drawings.

DISCUSSION/TEST QUESTIONS

How did you feel when your special place was littered?

Do you think that most people have a special place that they care about?

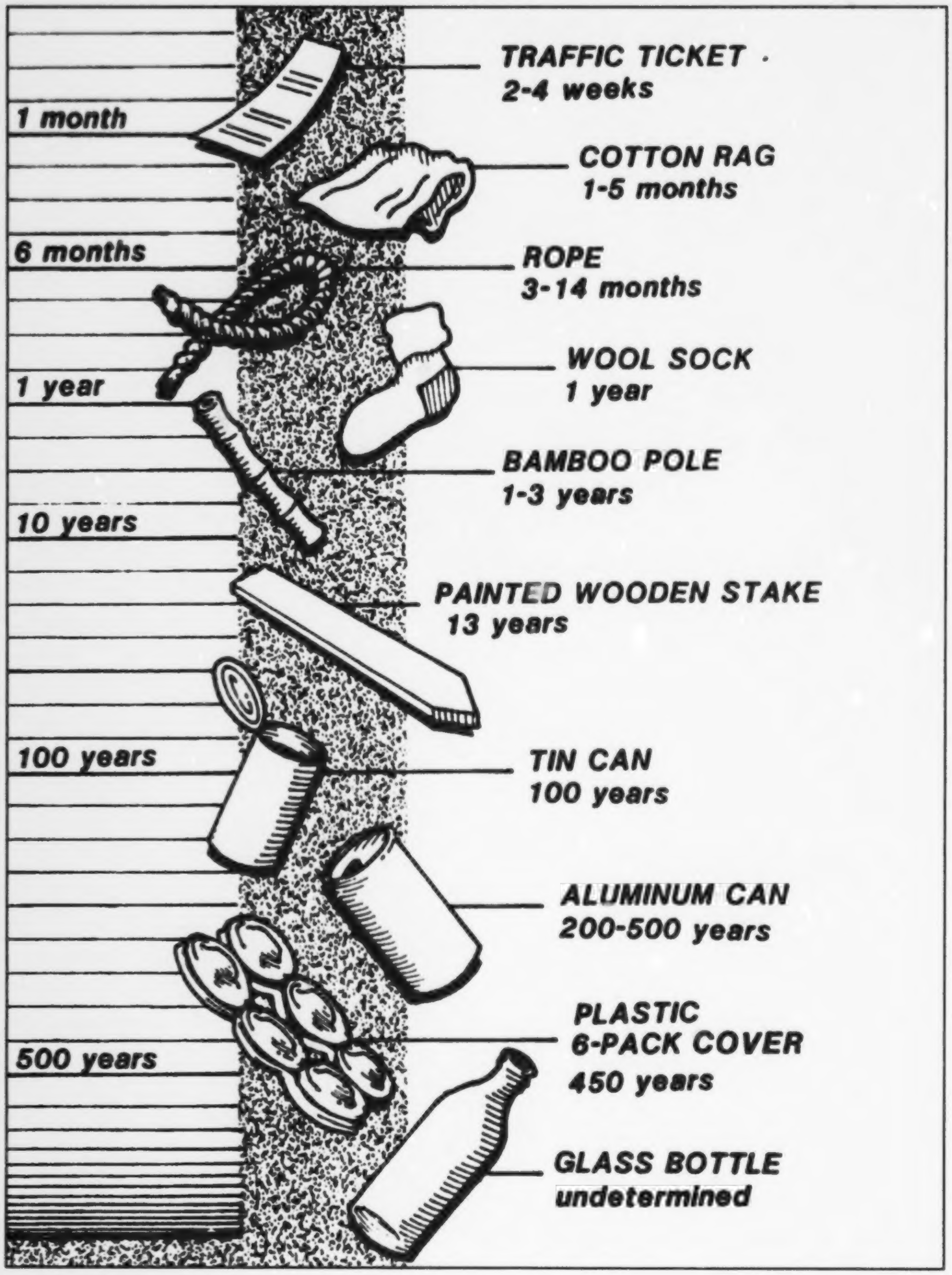
Can you think of things that people sometimes do that affect another person's special place?

What are other things people do that affect the environment?

Adapted from ***CALIFORNIA STATE ENVIRONMENTAL GUIDE, 1988***

Enduring Litter

Litter at the roadside is ugly. How long it will stay before decaying may be an ugly surprise.



PLASTIC TRASH AND WILDLIFE

Goals:
Students will learn the negative effects of plastic solid waste on wildlife and consider what each can do to avoid adding to this problem.

School Subject:
Environmental Education, Social Studies, Home Economics.

Grades:
6th - 12th

Time:
1- 2 class periods

Materials:
- Included article "Plastics at Sea" from Natural History Magazine 2/83

BACKGROUND

Since the early 1970's, the amount of plastic in the marine environment has increased dramatically. Plastic negatively affects wildlife in a number of ways. Some animals, mistaking plastic for food, eat it. For example, sea birds are known to have eaten plastic in the form of pellets, bits of styrofoam, even plastic toy soldiers. In addition, sea turtles, apparently regarding plastic bags as jellyfish upon which they regularly feed, have been found with balls of plastic in their stomachs. (One such ball, when unravelled, measured 9 feet wide and 12 feet long.) Other animals found to have eaten plastic in one form or another are: whales, dolphins, bottom fish, a manatee, sea snails and worms, and plankton. Another damaging effect of plastic trash on wildlife is the entanglement of animals in everything from six-pack holders to plastic rings, discarded fishing line and nets. Plastic debris is responsible for the death of 100,000 marine mammals. "Some government officials estimate that about 50,000 northern fur seals currently die in North Pacific waters each year as a result of entanglement in fishing gear." ("Plastics at Sea"). "In 1975, the National Academy of Sciences estimated that commercial fishing fleets alone dumped more that 52 million pounds of plastic packaging material into the sea and lost approximately 298 million pounds of plastic fishing gear, including nets, lines, and buoys." ("Plastics at Sea")

PROCEDURE

1. Have each student pick up or list all items of plastic litter and trash found in a 50-yard stretch along a beach, lake, river, or stream near his/her house. Bring lists or bags of litter to class.

2. Discuss: What nonrenewable natural resource is plastic made from? (petroleum) What uses other than making plastics can you think of for this resource? Referring to the collected plastic litter

Ask: What other material or container could have been used in place of this piece of plastic? Why is plastic litter even more of a problem than many other kinds of litter? Where did all this plastic come from? Why do people litter? Do you litter?

3. Have students make a list of the wildlife commonly found in the area where the plastic litter and trash were recorded or collected.

Ask: How will this plastic affect the wildlife we have listed? In what ways might this plastic litter endanger wildlife? Show accompanying pictures and share some of the information from Teacher Background.

Ask: Why is so much material that harms wildlife manufactured? What can each of you do to lessen the negative impact of plastic trash on wildlife?

4. Have students read Plastics at Sea.

DISCUSSION/TEST QUESTIONS

What nonrenewable natural resource is plastic made from?

Why is plastic litter even more of a problem than other kinds of litter?

In what ways does plastic waste and litter endanger wildlife?

Adapted from ***A-WAY WITH WASTE, 1985, and THE FOURTH R, 1985***

PLASTICS AT SEA

by D.H.S. Wehle & Felicia C. Coleman

Throughout the 1970's, a number of biologists studying the feeding habits of sea birds in different oceans of the world recounted the same story: the birds were eating plastic. Similar reports of plastic ingestion and of entanglement in plastic debris began to surface for other marine animals - fish off southern New England, turtles off Costa Rica and Japan, whales in the North Atlantic. At the same time, plastic particles turned up in surface plankton samples from both the Atlantic and Pacific oceans; plastic debris was retrieved by benthic trawls in the Bering Sea and Britain's Bristol Channel; and plastic pellets washed ashore in New Zealand in such large numbers that some beaches were literally covered with "plastic sand". By the close of the decade, marine scientists around the world had become aware of a new problem of increasing ecological concern— plastics at sea.

Two forms of plastic exist in the marine environment: "manufactured" and "raw". Manufactured plastic material along beaches and adrift at sea is primarily refuse from transport, fishing, and recreational vessels. In 1975, the National Academy of Sciences estimated that commercial fishing fleets alone dumped more than 52 million pounds of plastic packaging material into the sea and lost approximately 298 million pounds of plastic fishing gear, including nets, lines and buoys.

Raw plastic particles - spherules, nibs, cylinders, beads, pills, and pellets - are the materials from which products are manufactured. These particles, about the size of the head of a wooden match, enter the ocean via inland waterways and outfalls from plants that manufacture plastic. They are also commonly lost from ships, particularly in the loading and unloading of freighters. Occasionally, large quantities are deliberately dumped into the sea.

Much of what we know about the distribution patterns and abundance of raw plastic in the world's oceans comes from plankton sampling of surface waters. Inevitably, many animals foraging in the marine environment will encounter and occasionally ingest these widely distributed plastic materials.

Sea birds choose a wide array of plastic objects while foraging: raw particles, fragments of processed products, detergent bottle caps, polyethylene bags, and toy soldiers, cars, and animals. Marine turtles on the other hand, consistently select one item - plastic bags. In the past few years, plastic bags have been found in the stomachs of marine turtles. Polystyrene spherules have been found in the digestive tracts of one species of chaetognath (transparent, wormlike animals) and eight species of fish in southern New England waters. They have also turned up in sea snails and in several species of bottom-dwelling fishes in the Severn Estuary of southwestern Great Britain.

Marine mammals are not exempt from participation in the plastic feast. Stomachs of a number of beached pygmy sperm whales and rough-toothed dolphins, a Cuvier's beaked whale, and a West Indian manatee contained plastic sheeting or bags. In addition, Minke whales have been sighted eating plastic debris thrown from commercial fishing vessels. Curiously, plastic has not been found in any of the thousands of fur seal stomachs examined from Alaska.

The obvious question arising from these reports is, why do marine animals eat plastic? In the most comprehensive study to date, Robert H. Day of the University of Alaska maintains that the ultimate reason for plastic ingestion by Alaskan sea birds lies in plastic's similarity - in color, size, and shape - to natural prey items. In parakeet auklets examined by Day, for example, 94 percent of all the ingested plastic particles were small, light brown, and bore a striking resemblance to the small crustaceans on which the birds typically feed.

Marine turtles also mistake plastic objects for potential food items. Transparent polyethylene bags apparently evoke the same feeding response in sea turtles as do jellyfish.

Sea birds, marine turtles, and marine mammals all eat plastic. So what? Perhaps ingesting plastic is inconsequential to their health. After all, cows are know to retain nails, metal staples, and strands of barbed wire in their stomachs for more than a year with no ill effects. For marine animals, however, the evidence is growing that in some cases at least, ingested plastic causes intestinal blockage. George R. Hughes of the Natal Parks Board, South Africa, extracted a ball of plastic from the gut of an emaciated leatherback turtle; when unraveled, the plastic measured nine feet wide and twelve feet long. There is little doubt that the plastic presented an obstruction to normal digestion.

The 20 dead birds discovered on a beach in southern California, all with plastic in their digestive tracts, present a less clear case. Did the birds suffer an adverse physiological response after eating plastic or were they already under stress because of a reduced food supply and eating the plastic in a last-ditch effort to prevent starvation? The same question applies to other instances of emaciated animals that have eaten plastic. At this time, we don't have an answer.

We do know that plastic is virtually indigestible and that individual pieces may persist and accumulate in the gut. Ingested plastic may reduce an animal's sensation of hunger and thus inhibit feeding activity. This, in turn, could result in low fat reserves and an inability to meet the increased energy demands of reproduction and migration. Plastic may also cause ulcerations in the stomach and intestinal linings, and it is suspected of causing damage to other anatomical structures. Finally, ingestion of plastic may contribute synthetic chemicals to body tissues. Some plasticizers, for example, may concentrate in fatty tissues, their toxic ingredients causing eggshell thinning, aberrant behavior, or tissue damage. When highly contaminated tissues are mobilized for energy, these toxins may be released in lethal doses.

A more obvious effect of plastic pollution is the aesthetic one. Whether we venture deep into the woods, high atop a mountain, or out on the ocean to escape the trappings of civilization, our experience of the natural world is often marred by the discovery of human litter. Even more disturbing to the spirit is the sight of a young pelican dangling helplessly from its nest by a fishing line, a whale rising to the surface with its flukes enshrouded in netting, or a seal nursing wounds caused by a plastic band that has cut into its flesh. Unfortunately, such observations are becoming more and more common, another consequence of plastics at sea.

During the last 20 years, fishing pressure has increased dramatically in all the world's oceans, and with it, the amount of fishing-related debris dumped into the sea. In addition, the kind of fishing equipment finding its way into the ocean has changed. Traditionally, fishing nets were made of hemp, cotton, or flax, which sank if not buoyed up. These materials disintegrated within a relatively short time and, because of the size of the fibers, were largely avoided by diving sea birds and marine mammals. With the advent of synthetic fibers after World War II, however, different kinds of nets came into use. These new nets were more buoyant and longer-lived than their predecessors, and some of them were nearly invisible under water.

The result of these changes in net materials has been a tragic increase in mortality of air-breathing animals. Incidental catch refers to nontarget animals that are accidentally caught in an actively working net. Another kind of net-related mortality is known as entanglement and refers to any animal caught in a net that has been lost or discarded at sea. Unlike working nets, which fish for specific periods of time, these free-floating nets, often broken into fragments, fish indefinitely. When washed ashore, they may also threaten land birds and mammals; in the Aleutian Islands, for example, a reindeer became entangled in a Japanese gill net.

Plastic strapping bands - used to secure crates, bundles of netting, and other cargo, are another common form of ship-generated debris. Discarded bands are often found girdling marine mammals, which are particularly susceptible to entanglement because of their proclivity for examining floating objects.

Sea birds that frequent recreational waters or coastal dumps are also subject to ringing by the plastic yokes used in packaging six-packs of beer and soda pop. Gulls with rings caught around their necks are sometimes strangled when the free end of the yoke snags on protruding objects. Similarly, pelicans, which plunge into the water to feed, run the risk of diving into yokes. If the rings become firmly wedged around their bills, the birds may starve.

Not all encounters with plastic prove harmful to marine organisms. Some animals are incorporating the new material into their lives. Algae, marine worms, and small crustaceans attach to plastic floating at sea; bacteria proliferate in both raw and processed plastic refuse.

Plastic provides these organisms with long lived substrates for attachment and transport; in some cases, hitching a ride on floating pieces of plastic may alter an organism's normal distribution. Several species of tube-dwelling polychaetes construct the tubes of raw plastic particles present in benthic sediments. Marine birds all over the world incorporate plastic litter into their nests, but in this case, the use of plastic may be harmful because chicks can become entangled in the debris and die.

Instances of marine animals adapting to this new element in their environments do not alter the predominantly negative effect of plastics at sea. The problem is global and its solution will require international cooperation. Historically, the high seas have, in many respects, been considered an international no-man's land. Recently, however, perception of the ocean as a finite and shared resource had caused many nations to express concern for its well-being.

Originally printed in **NATURAL HISTORY MAGAZINE, FEBRUARY, 1983**

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SOLID WASTE: WHAT'S MY RESPONSIBILITY

BACKGROUND

People often feel powerless to do anything about enormous economic, political, or social problems. Solid waste is an example of an issue where personal action toward a solution may seem insignificant. But even if individual action by itself cannot solve these large problems, it can be the basis for a positive, personally enriching way of living.

Goals:
By using solid waste as an example, students will examine how their perception of a problem affects their response to that problem. Students wil examine the individuals' and government's responsibility solving problems and will define ways that they, acting as individuals or in a group, can take responsibility for solutions.

School Subject:
Government, Contemporary Problems, Ethics.

Grades:
9th - 12th

Time:
1 - 2 class periods.

Materials:
Copies of "My Twenty Foot Swath"

PROCEDURE

PART I

1. Have students read the following article, "My Twenty Foot Swath".

2. Ask students questions about the man in the article:
   a. What worries this man?
   b. What does he try to do about it?
   c. Does he think his response is effective?
   d. What response do you make when faced with a problem of this kind?
   e. What is RAO? Have you ever felt RAO? In relation to what?

3. Use the problem of solid waste as an example of an area where RAO may have occurred for some people. Have students consider the following facts.
   a. The world is now generating between 500 million and a billion tons of solid waste each year and those figures could double every 15 years.
   b. The nation's 18,500 disposal sites occupy 500,000 acres.
   c. A thousand tons of uncompacted waste would cover a half-acre of land three feet deep.

   RAO is a likely response to a problem of this size.

4. Discuss the possible solutions to the problem of waste.

Ask: Who, ultimately, is responsible for solving our solid waste problems — county, state, or federal government, those we elect, only those who generate the waste, you?

a. Should government strictly regulate disposal of all types of household waste? Should government force people to recycle? Could these regulation be enforced? Would this be "Big Brother" or a necessary step to maintain our resources and environment?

b. Is it reasonable to expect that individual action has a chance of solving a problem of this size?

c. If not, what do you see happening? More and more land used for landfills? Massive contamination problems caused by these landfills? Increased ocean dumping? More resource recovery plants? Use of technology in a yet undiscovered way of handling waste?

PART II:

A Personal Responsibility Activity

1. Have the class identify a waste, litter or recycling problem as the man in the article did, and determine what to do about it. The solutions may or may not be immediately obvious. Individual action you can take right now:

    a. Start source separation and recycling at home.

    b. Be a responsible buyer. Look for products packaged in reusable and recyclable containers.

    c. Compost waste.

Adapted from ***AWAY WITH WASTE, 1985***

MY TWENTY-FOOT SWATH

by Kenneth V. Lundberg
Covenant Companion

"I worried so much about world hunger today, that I went home and ate five cookies." Did personal or global problems ever become so overwhelming that you were immobilized, or driven to some action that actually aggravated the problem? Have you experienced such frustration about the hopelessness of solving the problems of poverty, environmental pollution, or human suffering that you could avoid it only by deciding that you were powerless to do anything about their alleviation? This is called **Responsibility Assumption Overload (RAO)**. Here's how I dealt with this feeling.

I park my car away from my building at work. That way I get both exercise and a parking space, as everyone else competes for spots next to the entrance. My morning and late afternoon strolls take me on a stretch of lawn between the tennis courts and the soccer field, and across an occasionally used softball diamond. The lawn is twenty feet wide, more or less. Soft and green, it was originally very littered. Tennis players discard tennis ball containers (and their flip-tops), worn out sweat socks, broken shoelaces and energy candy bar wrappers. Soccer game spectators leave behind beer bottles and junk food cellophane.

In my early days it disgusted me, and my thoughts centered on ways of correcting the situation: writing letters to the campus newspaper (no doubt totally ignored); campaigning for anti-litter regulations (who would enforce them?); organizing a "Zap-Day" cleanup (leaving 364 days for littering). All my noble efforts would have demonstrated my indignation, raised my blood pressure, and attracted attention, but they would not have changed the appearance and/or condition of the area.

So, I decided to take ownership. I would be the solution. I did not tell anyone of this; it was probably against some rule or another. I decided that I would be responsible for the environmental quality of this twenty-foot swath. I did not care what other parts of the campus were like. They were someone else's problem. But each day, going from and to my car, I picked up litter.

At first, it was as much as I could conveniently carry. Then I made a game of it, limiting my picking to ten items each way. It was an exciting day when I realized I was picking faster than "they" were littering. Finally, the great day arrived when I looked back on my twenty feet of lawn - now perfectly clean.

Where did I put the litter? At first, I brought it into a wastebasket in the building, or took it to the car to bring home. Then a curious thing happened. One day, large orange barrels appeared at each end of my swath. Someone in maintenance had become my silent conspirator - periodically emptying and replacing the barrels. He, too, knew the wisdom of keeping a low profile about it all.

I've done this for several years now. Has general campus appearance changed? Not much! Have litterers stopped littering? No! Then if nothing has changed, why bother?

Here lies the secret. Something has changed. My twenty-foot swath - and me! That five minute walk is a high spot of the day. Instead of fussing and stewing and storing up negative thoughts, I begin and end my workday in a positive mood. My perspective is brighter. I can enjoy my immediate surroundings - and myself - as I pass through a very special time and space.

'It' is better because of me. I am better because of 'it'. We enjoy the relationship. Maybe, even, 'it' looks forward with anticipation to my coming.

Originally from the Covenant Press, adapted from ***AWAY WITH WASTE, 1985***

NURTURE SOME NATURE

PROCEDURE

PART I

1. Instruct students to pick up one piece of litter on the way to school or on the school grounds. Hold it up in front of class. What can you tell about litter from what we have gathered? What is litter? What kinds of things commonly end up as litter? Why do these things end up as litter instead of other things? Have students define what waste category each litter item falls into (i.e., glass, paper, aluminum, etc.). List on blackboard.

2. Ask students about their thoughts on litter. What do they feel about litter? Who litters? When? Why? Are there any dangers associated with litter? Are there fines? Why is litter bad? Where do you find litter?

3. Discuss facts about litter and recycling from the Solid Waste Background Information, and Recycling Background Information.

4. Divide the class into teams, giving each a litter bag. Conduct a five-minute litter hunt contest on the school grounds. Use a whistle or some other method to signal the end of the hunt.

5. Gather students into a circle or return to the classroom to see which team picked up the most litter. Have awards for quantity, volume, or weight. Have students decide if they found anything that could be recycled.

Goals:
By keeping an area in a park or other location free of litter, students will become aware of their responsibility and ability to solve the problem of litter.

School Subject:
Social Studies, Language Arts.

Grades:
PART I
2nd - 3rd
PART II
4th - 12th

Time:
2 class periods.

Materials:
Litter bags (available from local groups, such as AAA, recycling centers, local park districts).

PART II

As a follow-up to Part I, have students adopt a portion of land on the school ground, at the local park, a curbside, or some other part of town. They will be responsible as individuals, or as a class, club, family or school, to keep the area free of litter.

Adapted from ***AWAY WITH WASTE, 1985***

DISPOSAL OF SOLID WASTE

BACKGROUND INFORMATION

Because solid waste is concentrated in highly populated areas, it must be removed quickly and efficiently to prevent health problems. In the past, dumps were used which were simply piles of uncovered waste. They attracted rodents and insects, and were unsightly, smelly and a health threat. Sanitary landfills replaced these dumps in the 1970's, but it was not until 1981 that the burial of hazardous wastes was banned in these landfills.

There are several methods currently in use for disposal of solid waste. These methods include landfills, incineration, and recycling. In the United States, less than 10% of solid wastes are recycled, more than 5% are incinerated, and 80% are disposed of in landfills (Environmental Task Force, 1986).

Landfills

When we "throw away" something, it does not just "go away" — most of it goes into a landfill. A sanitary landfill is a site where solid waste is disposed of on land to prevent public health and safety hazards. Landfills have strict guidelines for placement. They must be constructed in areas where the possibility of contamination of groundwater will be minimal, with a series of pipes to remove leachate beneath a clay liner. Garbage must be compacted and covered with six inches of soil daily, and land must be reclaimed as landfill operations are completed.

Landfills are running out of room. Landfills are becoming "landfulls". Each day, Americans throw away 400 million pounds of food, junk 20,000 cars, and discard 18,000 TV's. The United States has 5% of the world's population, but produces 30% of the world's garbage.

Leaks from landfills can contaminate groundwater. These are called leachates, which are liquid wastes and can be formed when water mixes with buried waste. Leachates may contain a variety of hazardous materials, including household hazardous wastes.

Many of the materials buried are nonbiodegradable and will remain intact for centuries. Not only are the nonbiodegradables such as plastic unchangeable, but the things they contain, even though biodegradable, cannot be acted upon by decomposers and will also remain essentially unchanged for generations.

Incineration

Incineration (the burning of waste) reduces the amount of waste by about 30-40%. With recycling, incineration can at best reduce the amount of waste by about 80%. Incinerators can also be used to produce electricity, by generating steam with the burning waste, and using the steam to turn turbines. There are concerns about the need for air pollution controls to keep particulate matter from escaping into the air. Also, the ash remaining must be buried in a landfill, and this residue often contains toxic metals and dioxins, which are classified as hazardous wastes.

Recycling and The Need for Resource Recovery

Natural resources contained in wastes are growing more limited and are more expensive. We can no longer afford to waste energy or to discard valuable resources that are still usable.

The Three R's

Reduce. Everyone can help reduce the amount of waste produced in this country. Buy products that last longer, and only buy the amount of a product needed for the job. Support businesses that use less packaging.

Reuse. Reuse products instead of buying new ones, and swap with others products that are no longer being used.

Recycle. Take paper, cardboard, used motor oil, batteries, certain plastics, construction materials, etc. to recycling centers. Compost kitchen scraps and yard wastes.

Sources: ***GREAT, 1989, A-WAY WITH WASTE, 1985, ENVIRONMENTAL SCIENCE, 1988***

2001: A TRASH ODYSSEY

Goals:
Students will evaluate both the current solid waste disposal practices and future plans in their community.

School Subject:
Social Sciences, Science.

Grades:
9th - 12th

Time:
5 class periods.

PROCEDURE

1. By mail or phone, contact recyclers, landfill site managers, disposal company representatives, sanitation department officials, county environmental health officers, state agencies and planning officials. Find out the following as it applies to your community:

a. Quantities and types of materials discarded.

b. Where materials are finally disposed of.

c. Quantities and types of materials recycled, reused, and recovered.

d. Expense of solid waste disposal.

Other resources for this project may be:

Speakers: local government (city, county), state officials, Environmental Protection Agency (federal).

Government publications: contact local, state, and federal agencies for information.

2. Determine your community's plans for future solid waste disposal by asking:

a. How and where will solid waste be handled/disposed of in the future (landfills, energy production, recycling, etc.)?

b. How will future disposal sites be chosen?

c. What quantities of solid wastes will be generated in the future (more or less than present)?

d. What will happen to the cost of solid waste disposal in the future?

3. Evaluate your finding regarding your community's plans for solid waste disposal:

a. From your perceptions of the solid waste disposal situations, at the present and in the future, do you feel that your community has made adequate preparations for the future?

b. If you had the ability to change any aspects of the plan for future solid waste disposal in your community, what would you do?

c. From your research, make recommendations on how individuals in your community might become involved in determining future courses of action regarding solid waste disposal.

d. What individual action might you take to alleviate the problem of solid waste in your community?

Adapted from ***AWAY WITH WASTE, 1985***

THE PROBLEM WITH LANDFILLS

PROCEDURE

1. Using the Disposal of Solid Waste Background Information, discuss what is done with the trash in a landfill. Be sure to point out the difference between present landfills and dumps used in the past, and list the advantages of landfills.

2. Discuss the disadvantages of landfill disposal including leakage to groundwater, limited space, waste of natural resources and inclusion of non-biodegradable materials.

3. If time allows, have the class experience the Incredible Edible Chemical Landfill, page 101.

4. Lead the discussion toward alternatives to landfill disposal.

Goal:
Students will be able:
- to state the problems in disposing solid waste
- to describe how waste disposal methods may lead to contamination of the groundwater
- to critically discuss waste disposal options

School Subject:
Social Studies

Grades:
7th - 12th

Time:
1 - 2 class periods

Adapted from ***GREAT, 1989***

INCREDIBLE EDIBLE LANDFILL

Goal:
Students will be able to state some of the problems with landfills and waste disposal.

School Subject:
Social Studies.

Grades:
6th - 12th

Time:
1 class period (one evening of preparation)

Materials:
- Plastic mixing bowl
- 3 different flavors of jello
- Pistachio pie filling
- Chocolate pudding
- Butterscotch pudding
- Pineapple ice cream topping (chunky)
- Creme de menthe ice cream topping (syrup)
- Licorice swizzles
- Root beer barrel candy
- Jelly/nougat candy
- Iced blue lozenges

Optional:

- Plastic cars, insects, furniture, bottles, etc.
- Jar of water
- Vegetable oil
- Pieces of rubber
- Nails
- Dirt or Gravel
- Vinegar

PREPARATION

1. Using the plastic container as a mold, pour in a layer of jello and allow it to set. Remember the first layer poured will be the top of the landfill, but will have the rest of the layers on top of it in the bowl.

2. Add root beer barrels, licorice swizzles, or any other materials to the layer when it is partially gelled.

3. Pour successive layers and add barrels, etc. Allow mold to set.

PROCEDURE

1. Tell students: After studying some of the issues involved in chemical waste in the United States today, it should be interesting to see what kinds of decisions we can make regarding disposal and treatment. Here is a model of a chemical landfill. **Ask:** Can you identify the liner? Point out the leachate seeping out.

2. Challenge the students to eliminate the "waste" before the end of the period. Remove the liner so that the students can inspect the contents. (Explain that all materials are edible and list ingredients to the class.) Tell students: Our edible landfill will represent all the chemical waste in the United States today. Proper treatment of the waste will be represented by consumption of the jello mold. If each of us take an equal share of the jello mold and consume it, there will be none left at the end of the period. Whatever material remains will continue to be a problem for future generations.

3. Consume the "waste".

Alternative 1
The instructor can use different colors of jello and place toy cars, plastic insects, bottles, and candies such as gummy bears etc., into the layered jello. This is a more accurate graphic display of a landfill. The students would not, of course, consume such an inedible presentation.

Alternative 2
Another option is to use a jar of water, and add to it 2 oz. vegetable oil, 2 oz. vinegar, pieces of rubber, several iron nails, a handful of dirt or gravel and food coloring. Explain to the students that this jar represents various hazardous substances which may be present in a hazardous waste dump. Ask: How can this water be cleaned up? (Pieces of rubber could be pulled out with tweezers; nails could be removed with a magnet; dirt or gravel could be filtered out; oil could be soaked up with paper towel).

Here are some examples of applications for real life, using the model:

Model	**Real World**
Incredible Edible Landfill	chemical waste
mold	liner
root beer barrels	barrels of toxic waste
jello	chemical sludge
iced blue lozenges	aromatic, organic wastes
liquids formed	leachate
eating the jello	proper treatment
discarding the jello	illegal treatment
extra credit for eating	incentive

Although the Incredible Edible Landfill is not aesthetic or appetizing, neither is the problem of chemical waste!

Adapted from **THE INCREDIBLE EDIBLE CHEMICAL LANDFILL** by Rich Wagner, Wissahickon Senior High School, Ambler, PA and from **CALIFORNIA CLASS PROJECT, 1984**

INCINERATION

BACKGROUND

See the Disposal of Solid Waste Background Information for data on incineration.

PROCEDURE

1. **Ask:** Have you ever sat in front of a fire and watched a log burn down to ashes? Those ashes take up much less space than the log did. For this reason, people began burning the material deposited in landfills or dumps. The life of the dump could be extended because the ashes took up less space.

Near populated areas, large furnaces are used to burn wastes and the ashes are trucked to landfill sites and buried. This process of burning wastes is called "incineration". At resource recovery plants, recyclable materials are removed from the waste before it is burned. At waste-to-energy plants, the heat generated by burning the waste is used to create electricity. A possible drawback to incineration is that toxics can be emitted into the air. Pollution control devices are necessary to maintain air quality.

Ask: What enters the air when materials are burned? When do these burned particles become air pollution? Can the burned material be recycled?

2. This part of the activity will demonstrate what happens to wastes during incineration. It should be done outside and under adult supervision.

Goal:
Students will learn about incineration as a method of waste disposal.

School Subject:
Social Studies, English, Mathematics.

Grades:
3rd - 6th

Time:
1 class period

Materials:
- A one-gallon can with several nail holes in the side near the bottom; a metal screen large enough to fit on top of the can; five pieces of cardboard, 6" x 6" or 6cm; tape; enough garbage to fill a 6" x 6" or 6cm x 6cm box.

NOTE: do not use wet, organic materials.

Take the five pieces of cardboard and tape them together to form a box for the wastes you collected.

Fill the 1-gallon can with the wastes from the box. Light the materials on fire and put the screen on top of the can immediately. Observe what comes out of the can while the materials burn. Where does it go? Is everything that comes out visible?

3. After the fire is out and the ashes are cold, dump the ashes into the box. Compare the amount of space taken up by the ashes to the space taken up by the wastes in their former state.

Adapted from ***FOURTH R, 1985***

DECIDING WHAT TO DO

A Simulation of a Public Hearing:
Siting a Solid Waste Disposal Facility

BACKGROUND

Review the background information on solid waste, landfills, and incineration and also on hazardous waste. Have students collect information from newspapers, magazines, and television news shows on siting landfills or incinerators.

The class will conduct a simulated refuse disposal siting/solid waste management hearing with the students taking the roles (see description) of various participants in the waste management decision-making process. The disposal facility under consideration includes options for an incinerator only, landfill(s) only, or both. Other pertinent issues not explicitly on the hearing agenda but which have direct or indirect bearing on the waste management problem as a whole are:

- recycling and the role it should play in the overall waste management plan.
- waste prevention and reduction and what can be done to encourage it.
- reducing industrial waste through the establishment of waste exchanges or treatment facilities.
- controlling the content of the waste stream through the regulation of packaging, etc.

These issues and others are part of the many questions facing communities and government agencies the world over as they grapple with the cumulative effects that result from our "throw-away" culture.

Goal:
Students will:
- Understand the complexity of managing solid waste
- Realize the wide range of perspectives and values involved in making decisions about solid waste
- Understand that there is no one "right" or "correct" answer to most of the serious problems facing our society
- Learn an interdisciplinary decision-making process through role playing

School Subjects:
Science, Social Studies, Government

Grades:
9th - 12th

Time:
2 - 3 class periods, plus project of several weeks

Materials:
- Scenario and role descriptions
- Sample hearing agenda
- Newspaper and magazine articles on solid/hazardous waste management

PROCEDURE

1. Distribute copies of the scenario and a role description to each participating student in the simulation. For best results, role descriptions should not be shared by different groups. Tell the students that the problem closely parallels the actual situation in a number of California counties. The class' job is to understand and discuss the

solid waste problem and come up with solutions. The emphasis should be on possible alternative solutions and not just a single answer to the problem.

2. Choose a student to serve as County Commissioner/Hearing Examiner. Then choose other students to fill the other roles. You may wish to assign some roles to more than one student. For example, have two Journalists; one from a large newspaper and one from a smaller weekly publication; or one from a daily newspaper and one from a monthly magazine. If the class is large enough, let some of the roles be assigned to 2 or 3 students who will each study and research a particular aspect of their roles' concerns about the County's disposal strategies. Not all the roles are necessary, but the "hearing" will work best if at least the first 6 or 7 parts are included.

3. Explain to students that this simulation is not meant to represent any actual public hearing or governmental hearing process, but that many public bodies are required by law to solicit input and comment on complex projects that can affect human health and environmental quality.

4. Have students prepare to play their roles realistically and convincingly by having them contact their real counterparts in your county. From this research and the background information (and packet, if possible), have students add information to the parts. Encourage students to add substance and appropriate detail to their roles.

5. Hand out the sample hearing agenda or prepare a similar one. Assign a specific date or dates for the conduct of the hearing. Encourage all the participants to come prepared with either questions or a brief presentation as indicated on the agenda. When the hearing takes place, have that part of the class not playing specific roles serve as the County Council, both questioning the hearing participants and, in the end, reaching a decision about what to do with all that garbage.

Adapted from ***A-WAY WITH WASTE, 1990***

THE SCENARIO

County population is growing rapidly. The volume of solid waste produced in the county is growing even more quickly. Recent federal and state regulations have outlawed open dumping, so all the old dumps have been closed. To protect human health and the environment, safeguards must be built into any new sanitary landfill, but this makes them very expensive to construct and they must be monitored throughout their use and for many years afterwards. People have been attracted to live in the county because of its beautiful semi-rural character and thus are very sensitive about environmental degradation or property devaluation that may result from a landfill or large volume garbage burner being built nearby.

The County Public Works Department, which has responsibility for proper disposal of all municipal waste generated within the county, is increasingly concerned about the growing amount of waste and is considering both a mass burner and/or a new landfill. The existing landfill is filling up fast and given the long lead time needed to site and build a replacement, a decision about what to do with the county's waste must be made soon.

Environmental Activist

You feel strongly that more recycling could be done in the county. You think the county should require home source separation of recyclable materials such as aluminum, glass, and newspapers and that private or public garbage haulers should be required to provide separate pickup for recyclables. You'd like the county to institute a county-wide, per-can garbage collection fee schedule that allows as little as one pickup a month. You want the county to fund public education programs in recycling; programs both for citizens' groups and schools.

You oppose the construction of a resource recovery, waste-to-energy incineration plant. As an environmentalist, you are concerned about the effects of incinerator emissions on air quality. You understand that a mass burn incinerator will require huge amounts of refuse to operate efficiently and thus discourage recycling efforts, while at the same time presenting problems in disposing of the toxic fly ash generated. Nevertheless, you are aware that a landfill could cause considerable environmental damage to the land, air and water.

Recycler

You've been involved in recycling ever since the sixties when concerns about environmental degradation were first voiced. Profits have never been large and the markets for recyclables have never been particularly stable or reliable. Nevertheless, the satisfaction of knowing that your job is part of the solution and not part of the problem has always made the hard work and long hours worth it. After twenty years, you have carved out a secure market for your business and you are looking forward to relaxing a little, while letting the younger generation carry on the day-to-day work.

You are worried that a mass burn waste-to-energy type incinerator will cut the bottom out of the recycling market. Although you would like to see the city institute mandatory recycling and source separation, you recognize that your own business is probably too small to compete with the large waste management firms with which the city would most likely end up contracting for such a mandatory program. You are gratified that at last recycling is becoming a "big business" and thus respectable, but you are angry and a little bit frightened that you and your hard earned business will get lost in the shuffle.

Garbage Hauler

You own a garbage collection company. Your company is licensed by the state and franchised by the county. Your prime concerns are providing good service to a rapidly growing number of customers and keeping costs down. You are also concerned about county and state regulation of your business. In recent years, more of the task of running your business has been taken up with government forms and "red tape". You are concerned about the prospect of the county telling you how to set your collection fees, how the garbage itself must be picked up, and where you have to take it once it has been collected.

Spokesperson, Homeowner's Group

You are worried that the county may be planning to build a landfill or an incinerator near your home. You are upset about the roadway litter you're afraid would result. You are also concerned about the increase in rat, crow, seagull, and feral dog population that a landfill, no matter how well managed, inevitably brings. You are also worried that household hazardous wastes dumped into the landfill will generate toxic leachate that could contaminate your drinking water. You are angry when you think that a landfill or large volume garbage burner will drastically decrease the value of the house and land you've worked so hard to own.

As co-founder of the Ratepayers Against Incinerators/Landfills (RAIL) you have been asked by the organization to present RAIL's concerns at the upcoming hearing. You realize, however, that it is not enough to protest a specific site, but that appealing and feasible alternatives must be presented. For this reason your organization has come out in favor of increased recycling.

County Public Works Engineer

Your county department has responsibility for disposing of all waste generated within the county and for meeting federal and state regulations governing the disposal of waste. Part of your job is to design and build waste facilities such as landfills and mass burners. At the same time, you are required to ensure that these disposal facilities do not create hazards for the environment or human health. A great deal of your energy goes into selecting and evaluating possible disposal sites and advising county commissioners/council members on technical aspects of solid waste management. You are becoming alarmed at the rate of growth of the county's volume of solid waste. You are probably more aware of it than anyone else and realize the enormity of the county's solid waste problem. You ask yourself: "Where is all this stuff going to go?"

Lately, however, much more of your time has been taken up with public relations, dealing with the concerns and sometimes anger of citizens who question or challenge county solid waste policy or decisions. You believe that citizens need to be better informed about some of the scientific and technical issues that are part of deciding what is the best option. You are especially concerned that the press is playing up some of the more sensational but remote dangers associated with incinerators and landfills. It seems that no matter how well you document the safety of an incinerator or a landfill site, the media always plays up the negative aspects.

County Citizen

You lead a busy life. You like the convenience that some packaged and processed food gives you, though you are sometimes bothered by the amount of packaging left over. You know your county is growing rapidly but have been more concerned about other consequences of growth such as crime, crowded highways, and air pollution than you have been about an increase in garbage. Frankly, you'd like to throw your trash in the garbage can and forget about it, even though you know in the long run that your children or grandchildren may end up paying for it with a less healthy environment.

You are paying the garbage hauler and the county its taxes to take care of it for you. You don't feel you have enough time in your day to fool around with the trash, separating it for recycling.

Journalist

Your job is to ask hard questions, understand the important issues and report accurately the decision-making process. Time and time again you've been assured by elected officials that the city has its garbage problem under control only to learn later after careful digging that the plans made have proved to be inadequate to the mounting garbage generated daily through expanded growth. When you ask about safeguards for environmental and human health, the engineers and planners present seemingly endless numbers and graphs all purporting to establish the safety of the sites being proposed for the disposal facility.

Just this past week you received a tip that one of the County Commissioner's father-in-law has a substantial investment in the company that is proposing to build and manage a mass burner waste-to-energy incinerator. Before going public with this information you will have to spend considerable time verifying its accuracy; time you would much prefer to spend researching substantive issues.

Incinerator Plant Vendor

You believe that incineration is the best solid waste management method available. As an engineer with many years experience in waste management and chemical processes, you know that the technology for safe incineration is already available and you don't understand why some citizens are fearful and unwilling to trust your professional judgement. If asked, you would have no qualms about having an incinerator site next to your property.

You want your company to be selected for this county's contract. Your boss has promised you an especially attractive bonus if you can "land" this one. You also know that waste incinerators, under the right conditions, are good opportunities for investors.

Regulatory Agency Official

You have been assigned by your agency to carry out the state law as mandated by the state legislature. Your responsibility is to write and enforce regulations that will protect public health and the environment and yet still provide practical and economically feasible waste management facilities. You are sensitive to the public's view of you as a "faceless bureaucrat", yet you know that there is no perfect set of regulations that will please all the parties. From your past experience as a field inspector, you know that strict enforcement of the law doesn't always lead to the desired result of a safer environment. You are sometimes as frustrated as the public by the legal requirements built into the regulations as safeguards against unjust government actions, but which are all to often exploited by a few "bad eggs" at the expense of many. It is sometimes hard to remember that most individuals and businesses are honest and want to comply with the laws especially as it relates to the environment.

You have been asked to attend this hearing to explain the current state and federal regulations and how they affect the County's proposal for siting a disposal facility. You expect to be questioned closely by both citizen and industry groups.

County Commissioner/Council Members

Your job is to make the final decision about how to deal with the county's growing volume of solid waste, while taking into account the needs and interests of a broad range of county citizens and businesses. You have to understand both the technical information provided you by the Public Works Engineer and the anxiety of homeowners who feel threatened by the possibility of a landfill or mass burner in their area. You try to be pragmatic and fair. You also want to get re-elected to office.

Your role in the hearing is to conduct a landfill siting/solid waste management hearing by calling on and questioning the other role players. It is also your responsibility to seek the input of other class members who are acting as county commissioners/council members or as interested citizens. It is your responsibility to conduct an orderly and productive meeting. This means that each participant should be treated equally and that all points of view are given a fair hearing.

Scientist/Expert

You are a Professor of Geology at a nearby university specializing in Hydrology, the study of water movement in the earth. Your research has focused on groundwater flow and the scientific study of the problems associated with contamination from human activities. Your publications have appeared in numerous journals and your scholarly expertise has been acknowledged by many professional organizations throughout the world. As your reputation as an expert has grown, you have been called on to speak at a growing number of public hearings and workshops throughout the state, including testimony at legal trials on the safety of various disposal options with respect to potential and actual groundwater contamination. You know as a scientist that there is no such thing as certainty especially in a field like geology where most events are measured in millions of years and actual experimental verification is possible only on a limited basis. Nevertheless, you find yourself being asked to give yes or no answers to questions that scientific and technical knowledge can never provide.

The County Commissioner has asked you (for a fee) to examine the County's plans for disposal and to provide a brief report discussing the impacts that each option might have on the water supply now and in the future. At present the data available and current scientific models can only suggest in a most sketchy fashion what these impacts might be. You are worried that because of this each faction will seize upon those parts of your presentation that most closely supports their position and then point to you as proof of the "truth" of their claims.

County Attorney

The District Attorney's Office reviews all the County plans to ensure that the county does not violate any of the many governmental regulations that inevitably cover any large scale plan. Projects with the potential for environmental harm and/or human health effects are especially complex, involving as they do both technical and political issues. You have been assigned the job of monitoring the legal aspects of the County's Waste Management Plans.

As a recently graduated law student from a prestigious eastern university, you have been on the job for about a year. You feel you are ready to tackle a "real" assignment instead of all the routine jobs you've been handed during the past year. Anxious to establish yourself as a top notch lawyer, you welcome this assignment as the first step in your career as a public official. Like many other young lawyers, you have political ambitions and you know how crucial it is to perform well on this, your first big assignment.

Your boss, the District Attorney, is particularly concerned about the threat of lawsuits and other legal actions from various special interest groups such as nearby homeowners, industry organizations, environmental activists, etc.

Private Consultant

The County hired the firm you work for to study the various options for a garbage disposal facility. You have been part of the team that carried out the necessary research and your particular expertise is in the area of stack emissions in incinerators and other industrial combustion facilities. Your supervisor is out of town this week and you have been tapped to represent the firm if any questions arise concerning the recommendations that were made to the county as part of your firm's final report. Since a mass burner was included as part of the recommendation, you expect to be sharply questioned on this aspect of the overall strategy your company proposed.

Toxicologist

You work at a federal government laboratory studying the effects of chemicals on mice and rats. Most of your research is directed towards determining whether certain chemicals can cause cancer in humans and animals. The main research tool for doing this is to expose special strains of rats and mice to substances and observe whether or at what dosages tumors develop. You know that many people are doubtful about relating results from mice to humans, while others prefer to err on the side of caution. Skeptics point out that experimental animals are exposed to high doses of substances at levels not commonly found in a normal environment. You, however, know that in order to extrapolate to the low dose exposures that are typical of human environments, the 50-100 rats and mice must ingest enough toxin to produce a statistically significant number of cancers. Estimates of a substance's cancer causing potency is based on the extrapolation of the experimental animal results to low doses.

Several environmental organizations have expressed concern about production of dioxins by the incinerator either as smoke stack emissions in the air or as part of the fly ash that must be disposed of. Dioxins are a class of chlorinated organic compounds produced as by-products in the production of herbicides and other industrial products. At least one dioxin, TCDD, is the most potent carcinogen (cancer-causing substance) known in mice and rats. The evidence for its cancer production in humans is not, however, established and scientists disagree as to what exposure levels are safe.

Farmer/Agriculture Representative

Your family has roots in the area that stretch back to the early pioneer days more than one hundred years ago. You have watched the county seat grow from a small town to a medium-sized city. You are concerned about the rapid growth and its effects on prime agricultural land. In your view, building a mass burner will encourage more growth and you know that your family farm may ultimately be threatened by this growth. Taxes continue to increase and you have farmer colleagues who have been forced to sell their acreage due in part to rising property taxes. You feel strongly about your stewardship of the land and are worried that your family's longtime ties to the land may be broken.

Real Estate Developer

You believe that progress must necessarily include some environmental disruption, but that the economic payoffs for the area far outweigh the short term pollution of a "few" streams or the conversion of some prime agricultural land for suburban housing and shopping centers. If most environmentalists had their way, the county would soon stagnate from the many regulations and restrictions that stifle growth. You are convinced that the expansion now underway must not be interrupted and that desirable "high tech" industries can be attracted to the area only if they can be assured that there are adequate waste disposal facilities.

You believe that growth is inevitable and that even if there are some minor problems now, scientists and engineers will come up with the necessary technology in the future to solve them. Sure, in the past, some mistakes were made, but there are plenty of safeguards built into the law now and besides, it has always been necessary to "break a few eggs to make an omelet". You believe that a waste-to-energy incinerator with its capability to generate electricity is just the ticket for the continued economic health of the county.

Chamber of Commerce Representative

You have been a member of the local business community for 20 years. Your business has been slowly growing after a struggle to make ends meet for the first 10 years. However, the recent recession has caused you great concern: will you be able to meet the costs of college education for your two teenage children? A waste-to-energy plant would bring cheaper electrical power rates, and build an economic base in the county. Recycling efforts could bring in a few jobs, but larger companies outside the area are already prepared to initiate large scale recycling efforts. A new landfill might cause a reduction in business opportunities, tourism, and residential growth.

Public Hearing on Proposed Municipal Refuse Disposal Facilities

Agenda

1. Opening statement - County Commissioner

2. County Proposals - Public Works Engineer
   - A. Incinerator - mass burner
   - B. Sanitary landfill
   - C. Combination
   - D. Other options
   - E. Question period

3. Expert Reports

4. Citizen Testimony
   - A. RAIL
   - B. Organizations

5. Industry/Business Testimony

6. Final Summarization and Questions

7. Conclusion and Vote - Commission Members

8. Report of Proceedings by the Two Journalists

INTRODUCING THE 3 R's (Reduce, Reuse and Recycle)

Goals:
Students will:
- learn that everyone is a part of the waste problem.
- that the least expensive and easiest solutions are to reduce, reuse and recycle

School Subject:
Social Studies

Grades:
5th - 12th

Materials:
- Scraps of paper

PROCEDURE

1. Write on the board the words paper, toxics, garden, plastic, and glass. Pass out the "used" paper to the students. Have a student volunteer to have their desk be the "landfill", where all the class's "waste" will be stored.

2. Have the students select one of the words listed above and write it on their sheet of paper. Have them crumple the paper into a ball, and toss it gently into the "landfill".

3. **Say:** This is the discussion for today: garbage, both solid and hazardous waste. Americans throw away 3.5 to 7 pounds each per day. Included in the trash are hazardous materials such as cleaners, motor oil and pesticides. Encourage students to discuss what they threw away today.

4. **Say:** Americans throw enough garbage away in a year to cover 1000 football fields with a building 30 stories high. In one year, enough garbage is generated to have a convoy of garbage trucks halfway to the moon!

5. **Say:** The contents of the garbage is: 50% paper, 18% yard waste, 8% metals, 8.2% glass, 7.9% food, 6.5% plastics and 1% hazardous products.

6. **Ask:** Where does your garbage go when you throw it away? Have students share whatever information they have about local disposal.

7. Ask the students for a list of problems related to landfills. These might include: gas emissions, groundwater and soil contamination, hazardous air emissions, transportation costs (including the depletion of natural resources), hazards to workers, lack of landfill space.

8. What are some possible solutions? The 3 Rs!

REDUCE: Use a sponge instead of paper towels; use a glass, silverware or plate instead of paper cups, plates and utensils; write on both sides of a piece of paper.

REUSE: Use a lunch sack for more than one day (how many days can you use one?); use a plastic bag from a store as a beach bag, book bag, storage container, etc.; use plastic containers for other uses.

RECYCLE: Recycle newspapers, bottles, cans, plastics, car batteries, paint, automotive oil.

9. **Ask:** How many hours can a TV run on the energy saved by recycling an aluminum can? (3 hours) How many trees are saved for every ton of paper recycled? (17 trees).

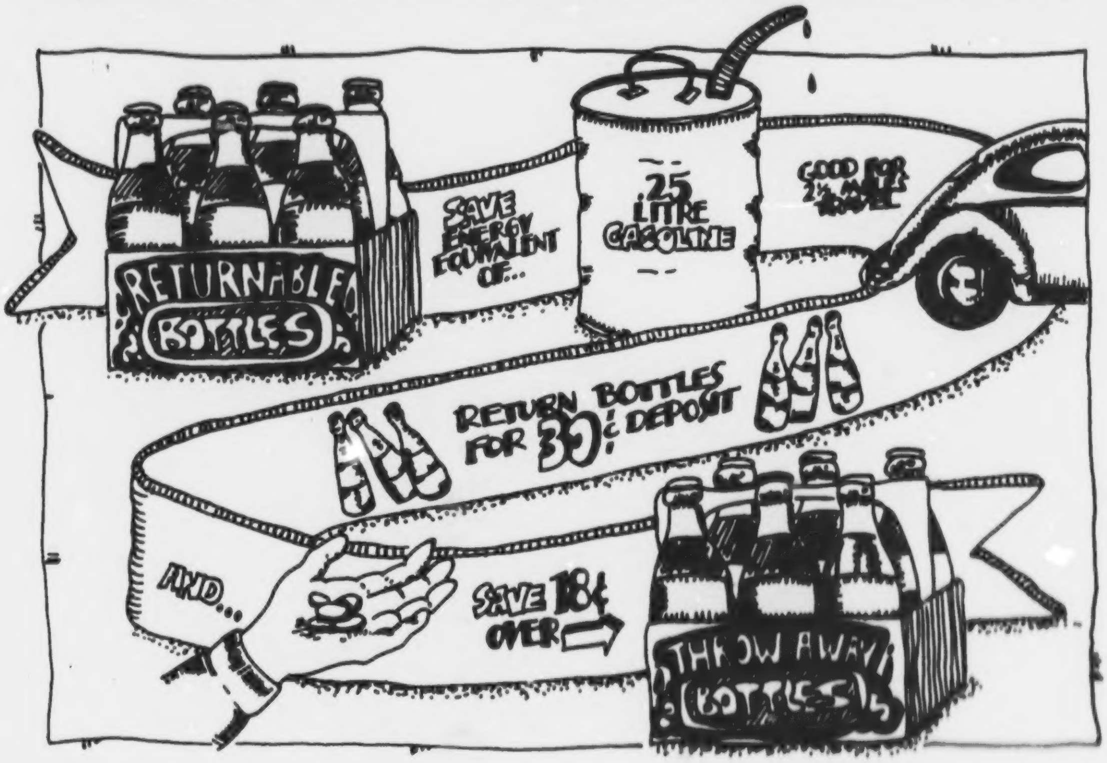
10. Say: When we use a landfill, we are throwing away millions of barrels of oil, hundreds of thousands of tons of steel, wood and aluminum ore. By recycling, we will have less logging of forests and less oil drilling off of our coasts.

11. Products made with non-recycled, virgin resources, such as trees, new steel, etc., typically create 10 times as much air, and water pollution. They use 2 times as much energy. They create fewer jobs and deplete resources that will be needed in the future.

NOTE: This is a good introduction to the activity *MAKING RECYCLED PAPER* on page 136.

Adapted from ***CALIFORNIA STATE DEPARTMENT OF HEALTH SERVICES ARCHIVES.***

DO RETURNABLE BOTTLES SAVE ENERGY?


RETURNABLE BOTTLES
SAVE ENERGY EQUIVALENT OF...
.25 LITRE GASOLINE
GOOD FOR 2½ MILES TRAVEL
RETURN BOTTLES FOR 30¢ DEPOSIT
AND...
SAVE 18¢ OVER
THROW AWAY BOTTLES

The purchase of a six-pack of soft drinks in returnable bottles instead of no-deposit no-return containers will save the energy equivalent of ½ pint of gasoline. The saving of ½ pint of gasoline can take the average family car about 2½ miles. In addition, when the empty bottles are returned for a 30-cent deposit, the six-pack purchase will have cost 18 cents less than for throw-aways

1. If each family in the class purchased one or two six-packs of returnable bottles each week for one year, how much energy in gasoline will be saved?
2. Using the figure from No. 1, how many miles of automobile travel are possible with the energy which is saved?
3. How much money is saved?
4. Why do you think so many people still buy beverages in throwaway containers?
5. What do you think the government should do about this matter? What will you do?

From: Iowa Energy Policy Council's **Energy Conservation Activity Packet**, Grade 6.

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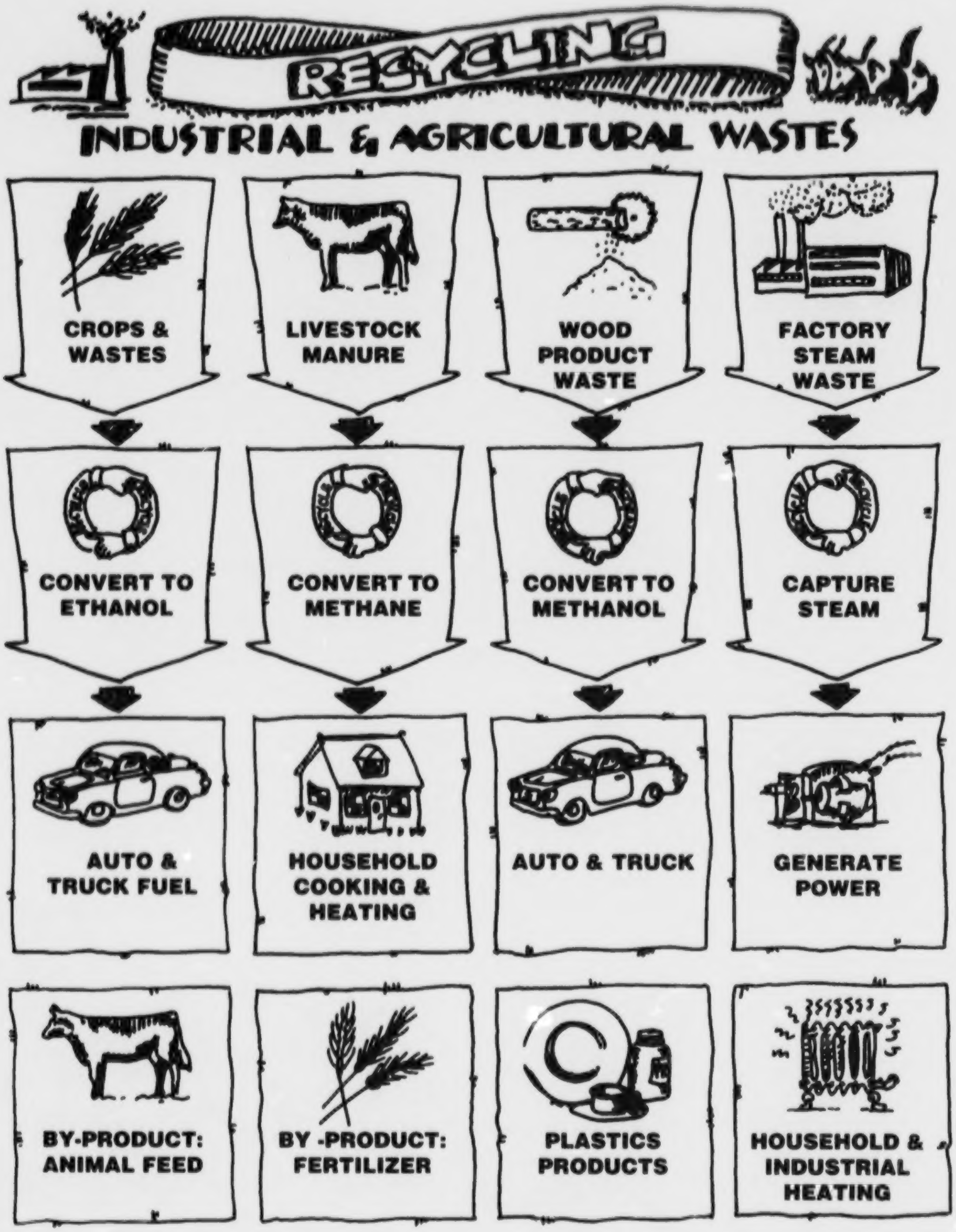
RECYCLING
INDUSTRIAL & AGRICULTURAL WASTES
CROPS & WASTES
LIVESTOCK MANURE
WOOD PRODUCT WASTE
FACTORY STEAM WASTE
CONVERT TO ETHANOL
CONVERT TO METHANE
CONVERT TO METHANOL
CAPTURE STEAM
AUTO & TRUCK FUEL
HOUSEHOLD COOKING & HEATING
AUTO & TRUCK
GENERATE POWER
BY-PRODUCT: ANIMAL FEED
BY -PRODUCT: FERTILIZER
PLASTICS PRODUCTS
HOUSEHOLD & INDUSTRIAL HEATING

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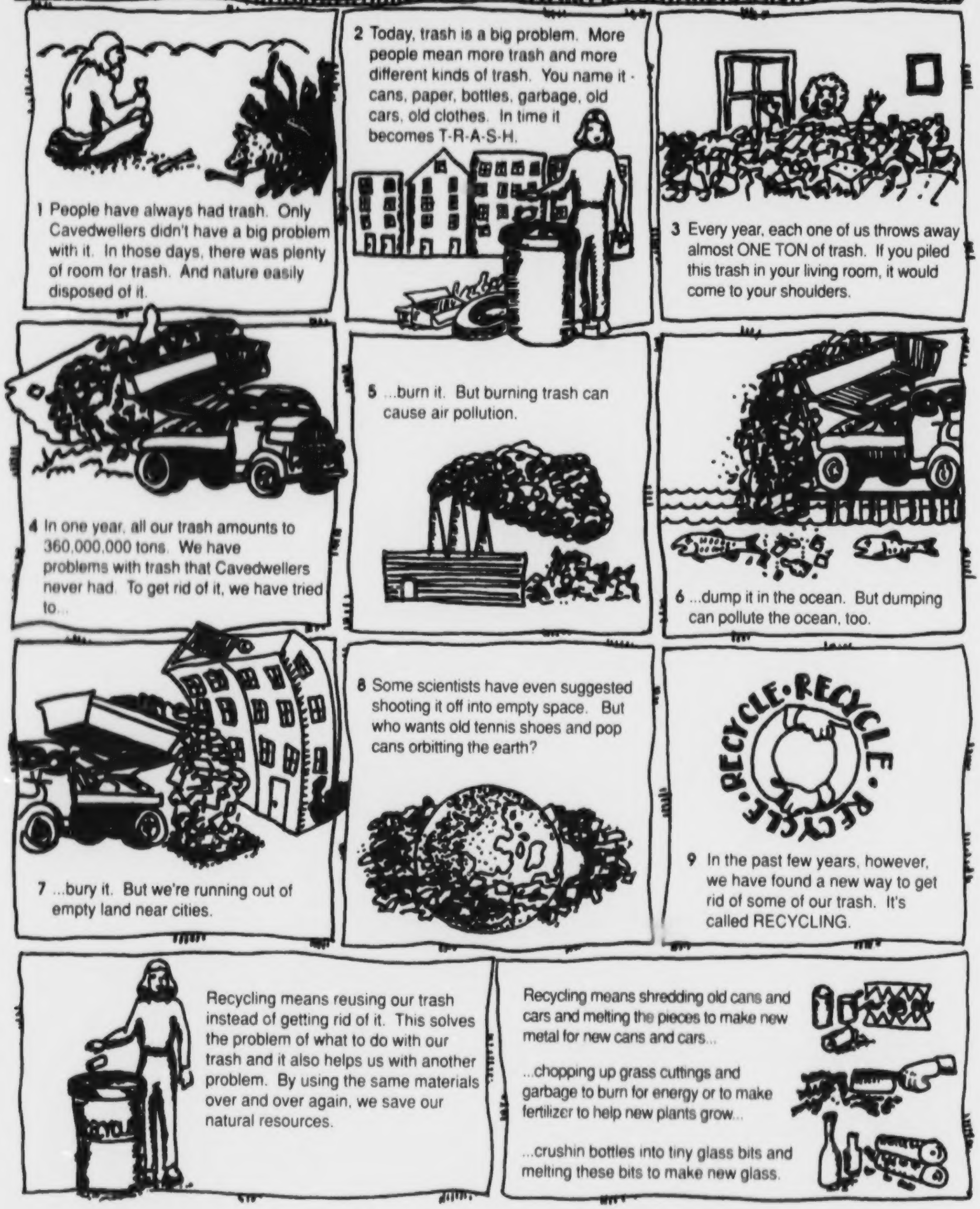
A VERY SHORT HISTORY OF TRASH



1 People have always had trash. Only Cavedwellers didn't have a big problem with it. In those days, there was plenty of room for trash. And nature easily disposed of it.

2 Today, trash is a big problem. More people mean more trash and more different kinds of trash. You name it - cans, paper, bottles, garbage, old cars, old clothes. In time it becomes T-R-A-S-H.

3 Every year, each one of us throws away almost ONE TON of trash. If you piled this trash in your living room, it would come to your shoulders.

4 In one year, all our trash amounts to 360,000,000 tons. We have problems with trash that Cavedwellers never had. To get rid of it, we have tried to...

5 ...burn it. But burning trash can cause air pollution.

6 ...dump it in the ocean. But dumping can pollute the ocean, too.

7 ...bury it. But we're running out of empty land near cities.

8 Some scientists have even suggested shooting it off into empty space. But who wants old tennis shoes and pop cans orbitting the earth?

9 In the past few years, however, we have found a new way to get rid of some of our trash. It's called RECYCLING.

Recycling means reusing our trash instead of getting rid of it. This solves the problem of what to do with our trash and it also helps us with another problem. By using the same materials over and over again, we save our natural resources.

Recycling means shredding old cans and cars and melting the pieces to make new metal for new cans and cars...

...chopping up grass cuttings and garbage to burn for energy or to make fertilizer to help new plants grow...

...crushin bottles into tiny glass bits and melting these bits to make new glass.

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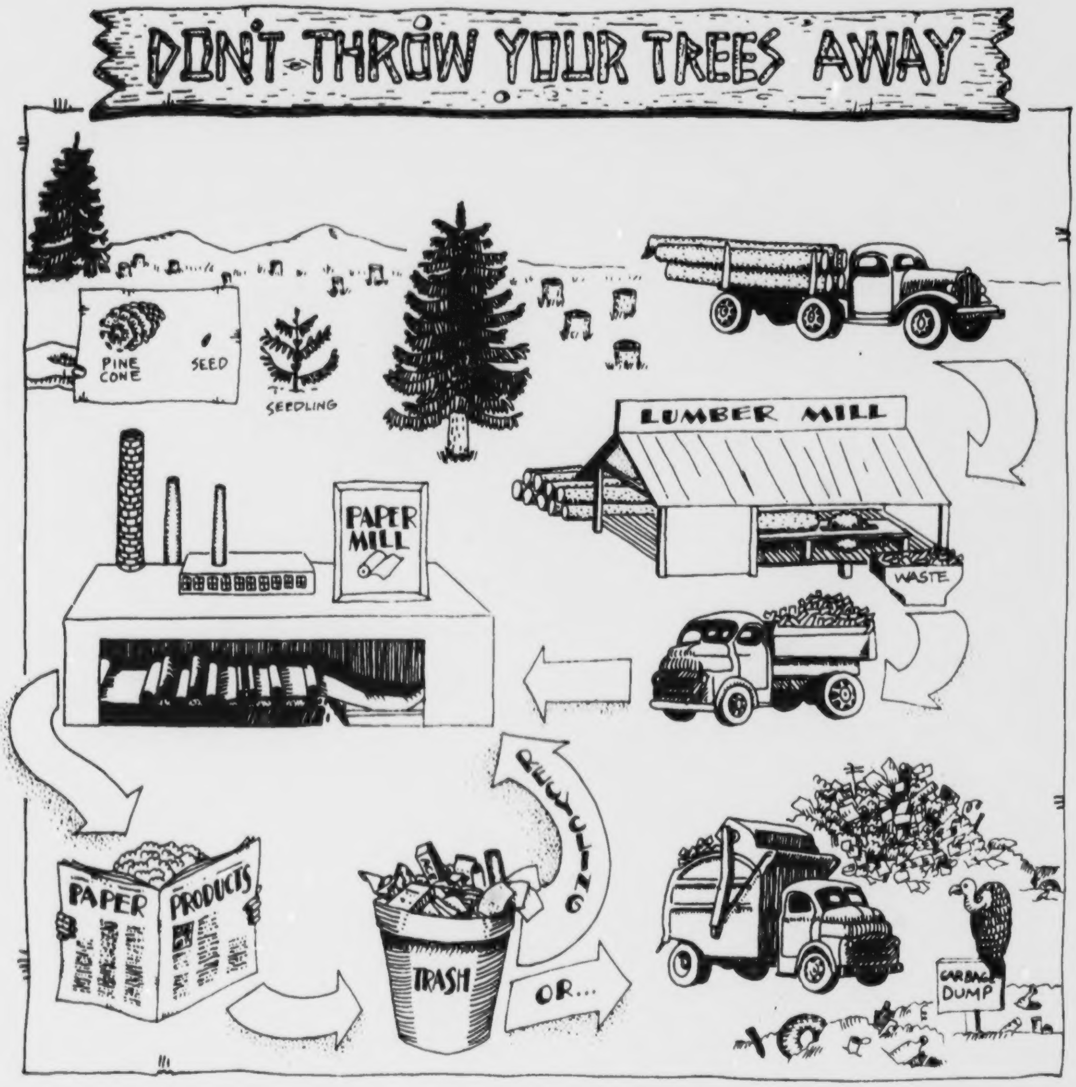

DON'T THROW YOUR TREES AWAY
PINE CONE
SEED
SEEDLING
LUMBER MILL
PAPER MILL
WASTE
PAPER PRODUCTS
TRASH
RECYCLING
OR...
GARBAGE DUMP

Each ton of paper that is recycled replaces and preserves an acre of harvestable trees.

The recyling of paper reduces waste and garbage pollution.

Recycling old paper uses 50 percent less energy than making new paper from trees.

BEST COPY AVAILABLE

EXTRA FANCY DUDS

PROCEDURE

1. **Ask students to bring samples of:**

a) "nature's packaging" (coconuts, bananas, peanuts, etc.) b) Packaging that could be reused or would biodegrade if discarded: returnable bottles, waxed paper, waxed paper milk cartons, pottery; (in early times most packaging was of this type: pottery jugs, woven baskets, animal skins, etc.) c) Excessive or difficult-to-recycle packaging; (plastics, styrofoam, plastic milk jugs, individually wrapped packets, etc.

As a class or in small groups, sort items into three categories. Discuss what the packages are made of, where they came from (i.e., trees, oil, bees, etc.)

2. Bring two apples to class and a fancy bow. Show the apples to the students, placing the bow on one of them. Ask them which one they would like to buy. What make them want one apple over the other? How do people package things (products) so that it makes you want to buy them?

Goals:
Students will be able to identy types of packaging and the ways that they are influenced to buy products that are overpackaged.

School Subjects:
Mathematics, Science, Social Studies

Grades:
K - 5th

Time:
One class period

Materials:
- Two apples
- Ribbon

DISCUSSION/TEST QUESTIONS

What does biodegradable mean?

What functions are served by packaging?

What is plastic made of?

After you open a package and empty it, where does it go?

Adapted from ***A-WAY WITH WASTE, 1985***

NECESSARY WRAPPERS?

PROCEDURE

1. Divide students into small groups.

2. Using packages of sugarless gum, pass out one stick to each child.

3. Ask each child to carefully unwrap the gum without tearing the wrappers.

4. Have each group create a poster by gluing wrappers on a piece of construction paper in a pattern. Glue wrappers in groups of 5 or 10 so that they can be easily counted.

5. Ask children to guess how many wrappers there are, then count them. Don't forget the outer wrapping and layers of packaging. Ask: If you chewed one pack on gum a week, how many wrappers would you have to deal with in a year?

6. Ask children why there are so many wrappers. Identify possible purposes of each. Ask: If you were going to package gum how would you do it?

7. Ask children to identify the source of raw materials for packaging; i.e., the plastic, the aluminum foil, the paper, and the gum itself.

8. Ask children to think of other things that their families buy that come in packages.

9. Ask: If we reduce the amount of packaging, will we reduce the amount of garbage?

Goals:
Students will realize that large amounts of packaging may be used to wrap products they buy.

School Subjects:
Mathematics, Science

Grades:
K - 5th

Time:
One class period

Materials:
- Packages of sugarless gum

DISCUSSION/TEST QUESTIONS

Where does packaging go if you throw it away?

How can you reduce the amount of packaging in your garbage can?

Name two types of packaging difficult to recycle. Two that are easy.

Adapted from ***A-WAY WITH WASTE, 1985***

WASTE, THEN AND NOW

PROCEDURE

Goals:
Students will:
- identify reasons why some American's way of living contributes to our country's massive trash problem.
- identify ways to revise their way of life so as to reduce the amount of waste they produce.

School Subject:
Social Studies, Home Economics

Grades:
5th - 12th

Time:
2 - 3 class periods

1. Food packaging contributes greatly to America's trash problem. (Approximately 40% of the average American household's trash is packaging material.)

a. List the trash produced through the consumption of foods (cans, boxes, plastic and glass bottles, paper products, plastic bags, and organic garbage).

b. **Discuss:** How did the Native Americans obtain food? (Hunting, gathering, fishing, farming, animal husbandry.)

c. **Discuss:** Did the Native Americans have a disposal problem? What did they do about it? (Shellmounds on the coast of California.)

d. Why were trash problems then different from those now?

e. **Discuss:** In what ways could we incorporate or modify Native American methods in order to produce smaller amounts of trash (grow our own food and animals, use biodegradable packaging, buy more unprocessed food).

2. In our society, we use tools of all kinds from disposable razor blades to electric can openers. Once broken or worn, we often discard these items as trash.

a. What tools or appliances have you used and thrown away in your household?

b. What is planned obsolescence?
c. What tools did the Native Americans use? (bones, bows and arrows, spears, knives, scrapers, bone awls,or needles).

d. What might we do the next time a tool or appliance is broken? (try to repair it, compare cost of repair to replacement cost.)

3. When we outgrow clothing, it goes out of style, or it gets worn, we often throw it into the trash.

a. Why would Native Americans have been unlikely to throw away old clothing? (hard to obtain, could be resewn into something else, didn't have excess clothing)

b. What might you do to reduce clothing waste? (give outgrown clothing away, don't buy too much, repair worn clothing, buy durable clothing that is less susceptible to changes in style.)

4. Can you think of items the Native Americans did not have which contribute to our trash prob-

lems? (cars, tires, newspapers, paper of all kinds, and plastic.) Can you think of ways to reduce these kinds of trash?

CONCLUSION

a. Why do we produce more trash than the Native Americans did? (Complexity of our culture — we don't make our own tools and clothing or directly obtain our own food. We use more manufactured and nonbiodegradable materials.)

b. What reasons can you think of for reducing waste? (reduce disposal costs, conserve energy and resources, improve the health of the environment)

c. List some things you will do to reduce waste in your home.

Adapted from ***A-WAY WITH WASTE, 1985***

A CAREFUL CONSUMER'S TRIP TO THE GROCERY STORE

Goals:
Students will understand:
- how recycled materials are used in packaging
- which natural resources can be conserved through careful buying and recycling

School Subject:
Home Economics, Social Studies

Grades:
6th - 12th

Time:
3 class periods

Materials:
- Instruction Sheets and Surveys Forms 1 and 2.

BACKGROUND

The Environmental Action Foundation in 1974 published research showing that the energy used to produce the packaging used by a fast food chain's hamburgers in a year was equivalent to the amount of energy required to supply the people of Boston, Washington, D.C., San Francisco, and Pittsburgh for a year.

Note in a discussion that 5 to 10%, or more, of the price of an item is for packaging alone.

"It would be nice if we could stop spending one out of every eleven dollars for packaging, most of which only ends up in landfills. Containers could be designed to hold more, occupy less space, and be reused."
(Dennis Moore, "Recycling: Where We Are Now. *New Shelter*, February, 1982. p. 69.)

PROCEDURE

1. Explain to students that for homework they will be conducting a survey of some grocery store products and packaging.

2. Review definitions of survey items:

Organic: derived from living organisms.

Renewable Resources: naturally occurring raw materials derived from an endless or cyclical source such as the sun, wind, falling water (hydroelectricity), fish, and trees. With careful management, the consumption of these resources can be approximately equal to replacement by natural or human-assisted systems.

Nonrenewable Resources: naturally occurring raw materials, which because of their scarcity, the great length of time required for their formation, or their rapid depletion are considered exhaustible. In other words, when they are gone, they are gone. Example: petroleum, metals.

3. Review how to identify packaging made from recycled materials — look for the recycling symbol. The grey paper-board used for cereal boxes is made from recycled paper.

4. Review survey forms, distribute surveys, "Product and Packaging Chart" and "A Potato by Any Other Name."

5. Give assignments, Survey 1 and Survey 2 and their instructions.

DISCUSSION/TEST QUESTIONS

Approximately what percentage of the cost of the packaged food you buy goes for packaging?

How can you reduce the amount of packaging you throw away?

Adapted from ***A-WAY WITH WASTE, 1985***

Survey Instructions

Survey 1:
Product and Packaging Chart

A. Choose 10 products and complete the Survey 1 chart for each.

B. Choose at least 2 products available in a choice of packaging.

C. By examining the products you chose, answer the following questions:
   a. Which products need special packaging to protect public health?
   b. Which product's packaging was made from recycled materials? (Look for recycling symbol.)
   c. Which products could be bought in bulk or in large containers?
   d. Which products could be bought in a less processed or packaged form?
   e. Which product's packaging could be improved to save energy and resources and reduce waste?

Survey 2

Find as many potato products as you can, at least 12. Use the chart "A Potato By Any Other Name" as a guide. Fill in the chart on Survey 2.

NOTE: Price per pound listing can be found on shelf labels beneath products. Analyze and discuss your findings:

A. What effect does processing and packaging have on a product's cost?

B. What effect does package size have on price?

C. What effect does package size have on the amount of waste?

D. What else is added to food as it becomes more highly processed?

E. List examples of recyclable packaging.

F. List examples of products for which recyclable packaging is not even a choice.

G. List examples of packaging made from recycled materials.

H. List ways people can reduce waste and increase recycling through careful buying.

BAKERS
CHIPS
FRIES
INSTANT
POTATO
BUDS

A POTATO BY ANY OTHER NAME

Product	Package Size	Price	Price Per Pound
Russets potatoes	Bulk		$ .59
White potatoes	Bulk		.49
Red potatoes	Bulk		.69
Fresh potatoes	5 lb.	$1.69	.338
Fresh potatoes	10 lb.	2.49	.249
Fresh potatoes	15 lb.	3.49	.232
Bel-Air* hash browns	2 lb.	1.29	.645
Bel-Air* french fries	2 lb.	1.59	.795
Bel-Air* shoestring potatoes	20 oz.	1.39	1.12
Ore-Ida potatoes O'Brien	24 oz.	1.49	.994
Ore-Ida golden fries	32 oz.	1.69	.85
Ore-Ida dinner fries	24 oz.	1.79	1.20
Betty Crocker potato buds (box)	28 oz.	2.99	1.70
Betty Crocker potato buds (box)	13.75 oz.	1.49	1.73
Town House mashed potatoes (box)	16 oz.	1.39	1.39
Town House white potatoes (canned)	15 oz.	.57	.608
S&W whole potatoes (canned)	16 oz.	.75	.75
O'Boises potato chips	6.5 oz.	1.15	2.83
Eagle potato chips	6.5 oz.	1.09	2.68
Pringles	7 oz.	1.50	3.42
Lays potato chips	7 oz.	1.58	3.61
Lays potato chips	10.5 oz.	2.28	3.47
Ruffles potato chips	15 oz.	2.75	2.93
Nalley's potato chips	16 oz.	2.65	2.65
Small order McDonald's french fries	3.5 oz.	.67	3.06

*Bel-Air is a Safeway Stores, Inc. private label. All store items priced on July 13, 1989 at Safeway in Redmond, Washington. McDonald's priced on July 22, 1989 in Redmond, Washington.

Survey Form 1

PRODUCT AND PACKAGING CHART

Product	Renewable Recyclable (e.g.paper)		Nonrenewable Resource (e.g. petroleum)		Is this product necessary?	Is this product available in more than one form of packaging?	If so, which is best in terms of recycling and waste reduction?	Is there an alternative to this product?	How could the packaging be inproved to save resources and energy?	What happens to this product's package when the contents are used?	Will this product's packaging become part of California's waste stream?
	Organic (derived from living organisms)	Renewable Recyclable Packaging	Nonrenewable Recyclable Packaging	Nonrenewable Nonrecyclable Packaging							

Survey Form 2

A POTATO BY ANY OTHER NAME

Product	Package Size	Price	Price per Pound

SOMETHING OLD, NEW, BORROWED, BLUE

Goals:
Students will see that trading is a good alternative to throwing away.

School Subject:
Social Studies, Art

Grades:
K - 6th

Time:
1 class period, plus additional time for swap meet.

PROCEDURE

1. Direct a classroom discussion dealing with the following concepts:

   a. The world has finite resources.
   b. We are rapidly using up some of these resources.
   c. If we can trade things rather than buy things, we conserve natural resources.

2. Organize a swap meet:

   a. Discuss what trading is: (role play, if necessary, to demonstrate) What can you trade?
   b. Determine the scope of the swap meet: class, grade, schoolwide? A swap meet can be held during lunch, after school, or as part of a school-community fair.
   c. Set guidelines for:

- Parental permission to trade objects
- Contract agreements with date and signature if part of trade is forthcoming in the future
- Trades involving intangibles or services such as guitar lesson, tutoring, time on friend's bicycle, or with friend's computer.

   d. Emphasize trading as a solution to the problem of sold waste and as a way to conserve natural resources. Ask: How can a swap meet help make this happen? List responses on the blackboard. Use these responses in letters to parents and on posters advertising the swap meet. Working with students, draw up a contract form for trades involving intangible items or services.

3. Hold your swap meet. Two of many possible ways to conduct it are:

a. Have students circulate and trade individually.

b. Conduct the swap meet auction-style. Have an "auctioneer" offer each item.

4. Have students keep a list of what was traded and what resources were saved because of the swap meet. Discuss opportunities in daily life to trade items (garage and yard sales, individual exchanges, notifications on bulletin boards in public places, etc.).

Adapted from **A-WAY WITH WASTE, 1985**

THE ART OF SOLID WASTE

PROCEDURE

1. Conduct a discussion on seeing artistic qualities in everyday items: line, form, elements of design, etc.

2. Research, and use as examples, works of art by artists who have used everyday items in their artwork.

3. Discuss how reducing our solid waste problem requires that people look at waste in new and creative ways.

4. Students collect for three days to one week all the potentially recyclable items that they normally would throw away, such as aluminum cans, bottles, paper, and plastic milk bottles.

5. Bring these items to class.

6. Using their own garbage (solid waste) students make a collage (poster size) or sculpture advocating the need to recycle. (All students may work together to create one large sculpture.)

7. Select titles for each piece to advertise the recycling program. Display at the recycling station in your own school, or other recycling centers in the community.

Goals:
Students will be able to use solid waste in an artistic manner to advertise the school recycling program.

School Subject:
Advertising, Art

Grades:
4th - 12th

Time:
One week

Materials:
- Recycable "garbage"

Adapted from ***A-WAY WITH WASTE, 1985***

RECYCLING

BACKGROUND INFORMATION

Today there is much discussion about recycling. Since the seventies, recycled paper has been an attractive alternative to wood fiber in making paper. Actually, the process of recycling is not new to the manufacture of paper in the United States. During the early colonial days paper was made from old clothing!

Paper is often referred to as the "handmaiden of civilization". It is vitally important in the field of knowledge as a keeper of records and as a medium for communication. The degree of civilization of a country may be measured by the amount of paper consumed. It is hard to imagine being without paper. The tools of the financial industry rely on paper. Consider not having paper money as a means of exchange. Also, industry and government would be unable to operate without paper.

Recycling today is again vitally important both from an economic and environmental standpoint. The rising costs of harvesting our forests, a growing accumulation of garbage and higher energy costs make paper recycling an attractive economic alternative.

The first link in the paper recycling process is the consumer who separates and saves waste paper. The collection of commercial quantities of waste paper is the second link. Waste paper processing facilities collect waste paper from businesses, from individuals delivering paper to the plant, or from groups conducting paper drives. Then the paper is processed and supplied to recycling mills. Mills process the old paper into new and attractive paper products which come back to the consumer. The cycle continues.

Some Paper Recycling Facts

- Recycling old paper uses 50% less energy compared to making paper from trees.
- Each ton of paper that is recycled replaces and preserves an acre of harvestable trees.

Recycling and Litter

Making aluminum from recycled aluminum uses 90-95% less energy than making alumnimum from bauxite ore, yet only 54% of all aluminum cans were recycled in 1981.

Environmentalists point out that surveys indicate litter taxes are not nearly as effective as beverage container deposit laws. EPA and General Accounting Office studies estimate that a national container deposit law would have a number of desirable effects, including saving consumers at least $1 billion annually. Roadside beverage container litter would be reduced by 60-70%, saving taxpayers money now used for cleanup.

Sources: ***CONNECTIONS, 1980, A-WAY WITH WASTE, 1985, and ENVIRONMENTAL SCIENCE, 1988***

MAKING RECYCLED PAPER

PROCEDURE

Goals:
Students will learn how to "recycle" paper into new paper.

School Subject:
Social Studies, Art.

Grades:
4th - 6th

Time:
1 - 2 class periods

Materials:
- Old newspapers
- A 1.5 gallon bucket
- Corn Starch
- A piece of screen for each student (approx. 8.5" x 11" or smaller)
- Rollers (coffee cans, dowels, rolling pin)
- Plastic

1. Three or four days before the presentation, shred newspapers and soak them in a bucket with water. Fill up the bucket with shredded newspapers and cover the newspaper with hot water. To help the paper break down, stir the pulp each day.

2. The day of the presentation, add some corn starch for smoothness and stability. Mix it until it is as uniform as possible.

3. Cover the students' desks with newspapers. Place a screen on each desk. Take a large handful of pulp and place it onto each screen. Instruct the students to mold the pulp into any shape they wish, but they should aim for "paper thin". Have them press the pulp with their hands to squeeze out the excess water.

4. Place a sheet of plastic over the pulp. Roll all excess moisture out of the pulp — similar to rolling cookie dough. Reshape the pulp gently if necessary.

5. Students can watercolor their new paper while it is moist or wait until it is dry. They can create a greeting card, a piece of art or anything that they imagine.

6. Allow the paper to dry until it peels easily off the screen.

Tell the students that they have recycled paper!

Adapted from ***California State Department of Health Services archives.***

NOT EVERYTHING MADE FROM SCRATCH IS THE BEST
(Recycling Aluminum)

BACKGROUND

Americans throw away 65 billion cans each year. Not all cans are aluminum. Aluminum cans are seamless and usually have label information printed directly on the metal. There are also bimetal cans (aluminum top with a steel body) and tin cans (99% steel).

The aluminum recycling process is fairly simple. First a magnet removes any steel cans, then the aluminum cans are flattened, shredded and made into pellets or bailed. These are sent to a smelting plant where they are melted, the impurities are skimmed off, and the metal is poured into molds and cooled. These go to a manufacturer who hot rolls them into sheets for use in cans, etc.

Other metals besides aluminum are recycled. Metals are divided into ferrous (containing iron and are magnetic) and nonferrous (without iron). Recycling ferrous metals is a huge industry and world trade in this type of scrap metal is well over $11 billion in comparison to $600 million for aluminum. Three million cars are junked yearly in the United States and are a big source, but iron is also recovered from food and beverage containers. The recycling of steel (instead of producing it from virgin sources) reduces energy consumption by 74%, air pollutants by 86%, water use by 76%, and mining wastes by 97%.

Note: a BTU is a measure of energy and is defined as the amount of energy needed to raise 1 pound of water 1 degree Fahrenheit.

Goals:
Students will:
- suggest reasons for the success of aluminum recycling
- generalize the ways that energy is used in the aluminum-making process
- Formulate a list of the benefits of recycling aluminum

School Subject:
Science, Mathematics, Social Studies.

Grades:
7th - 12th

Time:
1/2 class period

Materials:
- Student worksheet

PROCEDURE

1. Hand out student worksheets. Make sure students understand the definitions of BTU, nonrenewable resource, and biodegradable.

2. When students have completed the worksheet, discuss the answers.

Answers:

1. 94,317 lbs.; 42.9 tons.

2. Bauxite.

3. Carbon dioxide. It is necessary for plant growth, but can become harmful if too much collects in the atmosphere and traps the heat, producing the Greenhouse Effect.

4. Aluminum recycling's relative success is due to: its higher economic value; the aluminum industry's support for recycling because of concern for domestic amounts of bauxite; aluminum cans being easily collected; and the "bottle return" laws.

5. Petroleum coke and pitch.

6. Energy is also used in mining bauxite and other materials, transportation of raw materials to the processing plant, transportation of processed aluminum to the manufacturing plant, and transportation of the product to the consumer (sometimes through various distributors).

7. Recycling benefits include: conservation of land from mining practices; reduction in solid waste; reduction in litter; conservation of nonrenewable resources; reduction in air pollution; reduction in water pollution from mining practices and from less use of landfills.

Adapted from ***GREAT, 1989.***

Not Everything Made from Scratch is the Best
Student Worksheet

Recipe for One Ton of Aluminum

Ingredients

81, 766	lbs.	bauxite
11, 020	lbs.	petroleum coke
966	lbs.	soda ash
327	lbs.	pitch
238	lbs.	lime

Process with 197 million BTU's of energy.

Pollutants Generated

3,290	lbs.	red mud
2,900	lbs.	CO2
81	lbs.	air pollutants
789	lbs.	solid waste

1. How many pounds of material are required to make one ton of aluminum?_______lbs.

2. What is the ingredient that is used in the greatest quantity?__________________________

3. What is the pollutant that goes into the air in the greatest quantities?__________________
Is this pollutant harmful to our environment? If so, how?

Aluminum is made from bauxite, a nonrenewable natural resource. The United States is one of the largest manufacturers of aluminum but does not have large supplies of bauxite. Some bauxite is mined in Arkansas, Alabama, and Georgia, but most of the ore comes from foreign places such as Guyana and Jamaica. Bauxite ore lies near the surface of the earth, and most of it is mined by the open pit method. Explosives are put in holes drilled in the bauxite and the ore is blasted loose, loaded on trucks, taken to ships or railcars, and hauled to plants.

4. More than 50% of all aluminum cans are recycled, but all aluminum products such as lawn furniture and pie pans can be recycled. Aluminum recycling has been more successful than any other program. What do you think are the reasons for this success?

5. Does the recipe include any other nonrenewable resources? If so what are they?

6. Besides the 197 million BTU's of energy needed to actually make the aluminum, in what other ways do you think energy was used in the whole process of getting aluminum from the earth to the consumer?

7. Aluminum can be recycled for 96% less energy than it takes to produce it from "scratch". Besides this saving in energy, what do you think might be five other benefits of recycling aluminum rather than manufacturing it from bauxite?

(1)____
(2)____
(3)____
(4)____
(5)____

Did You Know?

- Each American uses 56 pounds of aluminum per year.
- If you drink two aluminum cans of soda per day and fail to recycle the cans, you are wasting more energy than a person in a developing country uses in one day.
- Twenty recycled cans can be made for the same energy as one new one.
- It would take an estimated 500 years to break down an aluminum can in a landfill.

PLASTIC IS A PROBLEM

BACKGROUND

About 80% of all plastics (thermoplastics) can be remelted and reformed but 20% cannot be reformed. In most processes, plastics can be recycled with similar plastics. Recycling plants receive baled, color-sorted bottles. The bottles are then ground up, fed through an air cyclone separator to remove paper, then gravity separated to remove the aluminum and the high density plastic of the bases. Next they are washed with caustic acid to remove adhesives, and sent through a water flotation system to separate usable and unusable plastics. The usable plastic (polyethylene terephallate or PET) is shredded, chopped, and made into pellets which are used to manufacture polystyrene fiberfill for jackets and sleeping bags.

Goals:
Students will be able to:
- define biodegradable and nonbiodegradable and give examples of each.
- evaluate the benefits and concerns about biodegradable garbage bags.
- list the benefits of recycling plastics.
- devise a plan to promote and carry out plastic recycling in their community.

School Subject:
Science, Social Studies, Biology, Economics

Grades:
7th - 12th

Time:
One class period

Materials:
- Student worksheets

PROCEDURE

1. Hand out the student worksheet. Be sure that the class understands the definition of nonrenewable resource. Have students answer the questions individually or in groups.

Answers:

A. Tape and milk jug.

B. Materials that can be broken down by microorganisms. Wrapper, sock, math paper.

C. The microorganisms cannot get in the bag, and there is not enough air and water for them to survive in the bag.

D. Market for corn, create jobs, have bags that degrade in landfills.

E. Some environmentalists are concerned that the dust-like plastic particles will get into the water and air, creating another problem. Others think that promoting the use of corn encourages destruction of habitat and soil erosion. Other questions include: Will they start to decompose while sitting on the lawn? Will they be as strong? Also, biodegradable plastic bags are estimated to cost 5-10% more than nonbiodegradable bags.

F. Keep it out of landfills, cut down on litter, provide more employment, save energy.

G. The long-term cost will be greater because of handling of nonbiodegradable materials in landfills, cleaning up litter, expended nonrenewable resources, pollution of groundwater because of continued need for landfills.

H. Recycling plastic jugs has much more potential for reducing the volume of waste in landfills.

Adapted from ***GREAT, 1989***

Plastic is a Problem
Student Worksheet

Iowa Companies Take the Lead in Finding a Solution

Stop! What's going to happen to that plastic bag full of trash that you just stuffed into the garbage can? To the garbage collector. OK, but what then? To a landfill. Right! But what then? To be buried. Yes, but what then? You're not sure?

You think you've heard something about plastic being nonbiodegradable? Do you know what that means? Did you know that if you could come back in a couple of hundred years and dig up that landfill, that plastic bag will still be there? You'd be able to recognize that sock with the hole where your big toe went, the wrapper form the bubble gum with the watermelon flavor, the bone from that chicken leg you had for dinner, the Michael Jackson cassette tape that your little brother ruined, the math paper that you spilled pop all over, and the jug that didn't quite have enough milk left for your cereal.

The plastic bag would still be there because it is nonbiodegradable. It cannot decay because it cannot be broken down by microorganisms. Archer Daniels Midland, a company with plants in Cedar Rapids and Clinton, Iowa, is trying to solve this problem. This company is using a technology brought from England that blends about 6% cornstarch with plastic for garbage bags. This substance is sent to a company in Missouri that produces bags that are at least partially biodegradable, leaving dust-like particles of plastic. Research is presently being conducted to check unanswered questions concerning the effect of the remaining dust-like particles on the environment.

However, some research suggests that garbage in landfills, no matter what it is bagged in, will not decompose very well. Conditions in a landfill are not as good for decomposition as they are in a compost pile. Remember that milk jug in your garbage? It is also nonbiodegradable. A company located in Iowa Falls is taking another approach to the plastic problem. The president of Plastic Recycling Inc. started the company because he could not get plastic particle board for hog confinements in the United States. He researched the technology that was used in England to make this product and developed the process that he now uses at his recycling plant. Plastic products such as your milk jug are recycled and made into car stops, park benches, fence posts, and other molded products.

Both of these companies are pioneers in their field and are using technologies that are at least the beginning of a solution to the plastic problem.

DISCUSSION QUESTIONS:

A. Plastic is nonbiodegradable. What items in the garbage bag mentioned in this essay are nonbiodegradable?

B. Define biodegradable. What items in the garbage bag are biodegradable?

C. If these items are biodegradable, explain what would cause them to be unchanged after 200 years?

D. The Archer Daniels Midland Company could benefit Iowa residents in many ways. List three.

E. What could be some environmental concerns about biodegradable plastic bags?

F. Plastics are part of the petrochemical industry which means they are made from natural gas and crude oil. The use of plastic beverage containers alone increased from 15 million in 1967 to 12.5 billion in 1985. Research shows that consumers prefer plastic containers of all kinds. Even such things as ketchup, salad dressing, and jelly come in plastic. List three benefits of recycling plastic.

G. Plastic Recycling Inc. gets much of the waste plastic it uses from Chicago. It was costing Illinois $1000 a week to landfill this plastic. The cost of recycled plastic products at this time may be higher but the long-term cost is much lower. Explain what is meant by this statement.

H. Which would reduce the volume of waste in landfills more: recycling plastic jugs or using biodegradable plastic bags?

MODEL CITY RELAY

BACKGROUND

More than half of the cost of waste disposal goes for hauling. Recycling not only saves energy but reduces water, soil, and air pollution.

In the city of Seattle, WA., waste disposal costs $56.00 a ton. In Philadelphia, PA., waste disposal is $90.00 a ton.

The teacher should be ready to explain to students which items can be recycled and reused.

Note: This is an outdoor activity.

Goals:
Students will:
- learn that recycling saves energy.
- plan a simple waste disposal strategy.
- learn what can be recycled.

School Subject:
Science, Social Studies, Physical Education

Grades:
4th - 8th

Time:
45 minutes or longer

Materials:
- One pile of 20-30 pieces of unsorted garbage for each team
- One large container for reusables
- One large container to serve as a landfill
- Model City Award certificates

PROCEDURE

1. Form teams of four or five students each. Explain that each team represents a community group competing for the coveted Model City Award Certificate. This award will be presented to the first team able to effectively deal with its waste. Photocopy the included award.

2. Set up the recycling and reuse receptacles approximately 20 feet from the starting line. Locate the large receptacle representing the landfill as far away on the playground as reasonably possible.

3. Before beginning the contest review different ways we can deal with waste. Ask: What reasons would communities have for locating their landfill as far away as possible? How does garbage get to a landfill? What costs are involved in getting garbage to a landfill?

4. Make sure each waste pile contains an equal number of recyclable or reusable items.

5. Explain the rules of the game: This is a modified relay race in which only one person at a time from each team can put something in one of the containers and only one item at a time can be deposited. Each group should plan how it will deal with its waste in the least time, and most energy-efficient way. Give each group several minutes to plan its waste disposal strategy then start the game.

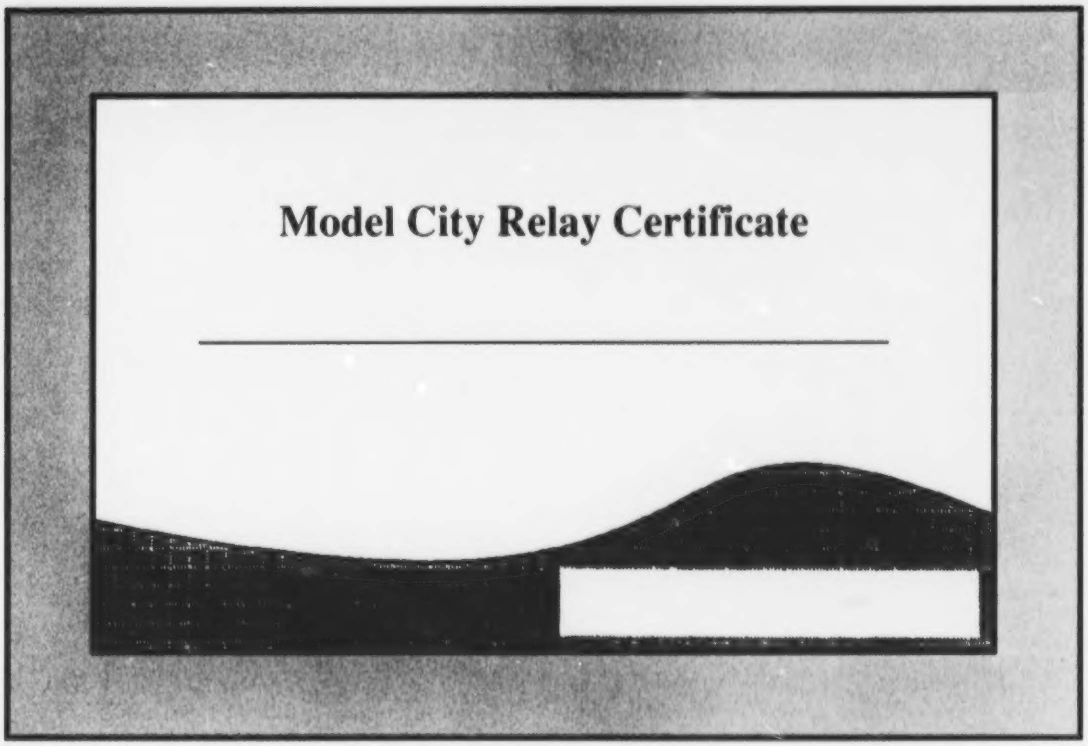
6. Monitor students' disposal choices to make sure that what students say are recyclable really are. (Students may also monitor.)

7. When the last team finishes with its waste, gather everyone together and have a follow-up discussion. Ask: What methods of waste disposal did the winning team use? (e.g. Team members recycled and reused materials to the greatest extent possible; team members continually sorted rather than waiting to sort before each run; team members invested more energy in waste disposal by running faster, etc.)

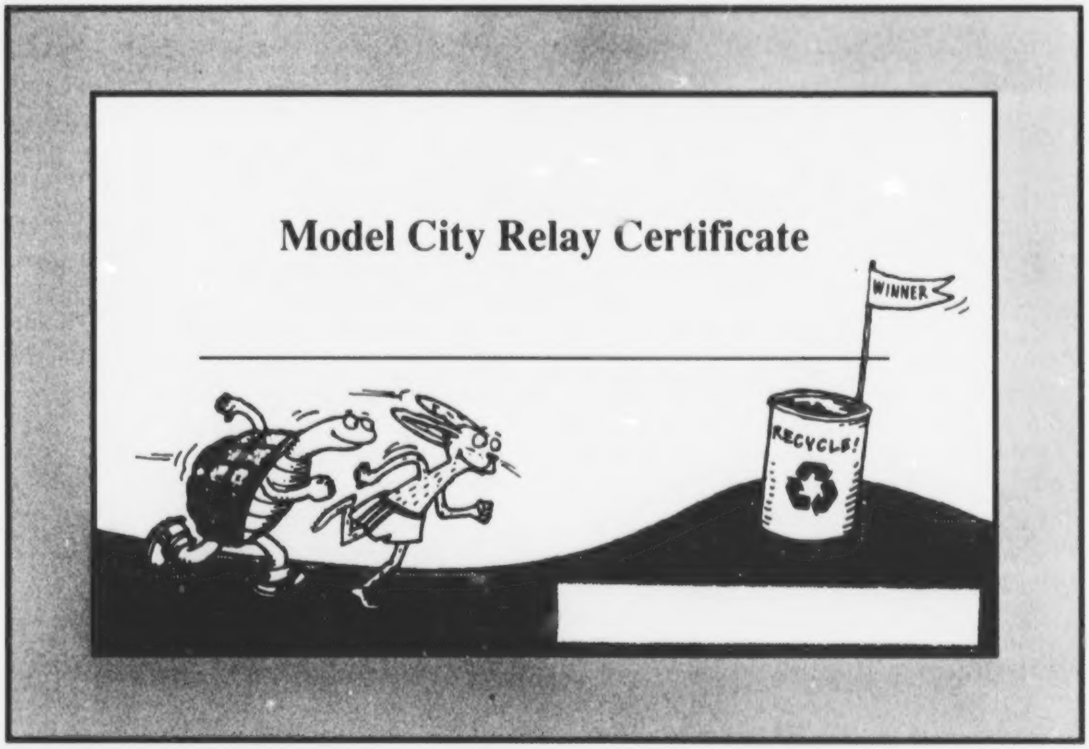
8. **Ask:** What does our town and county do with our waste? What have we learned from this game that might help our town and county better manage our waste?

9. Present the Model City Award Certificate to the winning team.

Adapted from ***A-WAY WITH WASTE, 1990***



Model City Relay Certificate



Model City Relay Certificate

WINNER
RECYCLE!

ECOLOGICAL PICNIC

Goals:
Students will plan and enjoy a picnic using a minimum of disposable items, then sort and recycle as much of the picnic garbage as possible.

School Subject:
Science, Social Studies

Grades:
3rd - 12th

Time:
30 minutes for planning, 60 minutes for the picnic, and 30-45 minutes after the picnic.

Materials:
- Typical lunch
- Two buckets or large cans for picnic garbage
- One bucket with a tight-fitting cover for composting
- Sawdust or dirt

BACKGROUND

People use disposable products for picnics and other occasions because there are no dirty dishes left over and no utensils that need to be taken home and washed. Just toss the products away and they seem to disappear. But there really is no "away"; all garbage must go somewhere. Any garbage that is not recycled contributes to the local landfill or becomes unsightly litter. This activity reinforces the idea that students can make personal choices about their actions. In this case they will be making choices that will minimize the amount of waste generated by a class picnic. After the picnic, students will collect the garbage that remains and recycle or compost what they can.

PREPARATION

Choose a site for the picnic (students may help choose). Possible locations are the schoolyard, a vacant lot, a park, a ball field, a lawn, or the side steps to the school building. If the weather is not suitable for an outdoor picnic, move it indoors. Push all of the desks aside and have the picnic in the middle of the classroom floor. Label the buckets to be used for garbage during the picnic. The one with the cover should be labeled "Food". The other buckets should be labeled "Cans" and "Other".

PROCEDURE

Day One

1. Decide upon a typical lunch that students might bring to school. Ask students to decide what items from the lunch would be thrown away. Ask if any of the pieces of garbage could be reused or recycled. Have students think of something that is reusable that could replace each disposable item (for example, flatware could be used instead of plastic spoons and forks).

2. Plan the picnic. Ask students for ideas about how they can pack a lunch that will produce the least amount of garbage. Explain that they will be making a friendship salad the day of the picnic and that they can contribute one or two pieces of fruit if they want to.

3. Send the included letter to parents telling them of the picnic and asking for volunteers.

Day Two

4. On the morning of the picnic, discuss garbage and cleanup. Point out that some things will need to be thrown away even though the picnic was planned and choices were made so that there would be little garbage. Show students the buckets or cans you want them to use for all of the garbage at the picnic. Explain that one bucket is for recyclable containers, one is for other garbage like paper and plastic. If there is water available at the picnic site, let students know that they can wash all dirty, reusable containers and utensils after the picnic.

5. One or more of the parent volunteers can help small groups of students wash and cut the fruit during the morning. Capture and reuse the water.

6. Remember to bring the three labeled buckets with you. Make sure students keep and sort their garbage after the picnic.

7. After lunch call the students together. Discuss what kinds of garbage are left over and what garbage isn't there because students made careful choices about what to bring. Make sure when the class leaves that no garbage is left at the picnic site.

After the Picnic

8. In the classroom put all of the food garbage from the picnic into the bucket for composting. You can layer the food with sawdust or dirt, if either are available. Make sure the cover fits tightly; open compost containers attract rodents and flies. Stir the mixture every three to five days for a couple of weeks. When most or all of it looks like dirt, use it. Add a little soil and plant flowers in it or mix it into the soil under a favorite tree. Let students know that compost is a kind of plant food; it contains many nutrients that plants use.

9. You or one of the parent volunteers can take the cans to the recycling center in your area or take a field trip to the center. Discuss with the students where the cans are going and why it is better for the environment to recycle cans rather than throw them away.

10. Discuss with students what they did during the picnic that was good for the environment and good for people. Let students express their ideas and feelings. Discuss savings of paper (trees), plastic and money.

11. Distribute paper and drawing materials and have students draw a picture of the picnic showing themselves and others doing something good for the environment. Older students can label their own pictures; younger students will need to dictate a sentence or two.

Discussion Questions

- What do you usually throw away after a picnic? - How could you pack a lunch for a picnic so you would have little or no garbage? - Why do you think people might want to use something that could be thrown away, even if they know it just makes more garbage? - Why is garbage bad for people, plants, and animals? - What kinds of garbage were left over after the picnic? - What other kinds of garbage might we have had if we didn't plan an ecological picnic? - What choices did you and other class members make that were good for the environment? Good for people?

Adapted from **CALIFORNIA STATE ENVIRONMENTAL EDUCATION GUIDE, 1988**

Dear Parent or Guardian:

As an activity on recycling, we are planning an ecological picnic on ______date______ at ______time______ to be held at ______________location______________. We have discussed ways to pack a lunch so that there will be as little garbage left over as possible (for example, using cloth napkins instead of paper napkins, bringing reusable silverware or reusuable plastic silverware, putting food in reusable plastic containers when possible, bringing juice or milk in a thermos). Please help your child pack an ecological lunch for the picnic.

We will recycle as much leftover garbage as we can. Cans and aluminum foil will be recycled. Leftover food that can't be saved will be composted.

We will make a friendship salad the morning of the picnic. Students will contribute the fruit. We will wash the fruit and chop it at school, then enjoy it for dessert at the picnic. If you can contribute to the friendship salad, please send one or two pieces of fruit with your child on ______date______ along with his or her ecological lunch.

Also, we need two or three parent volunteers to help make the friendship salad and supervise the picnic. If you can join the fun and help out, please let me know.

Thank you.

BEST COPY AVAILABLE

LOGOS AND SLOGANS FOR RECYCLING

PROCEDURE

1. Study examples of well-known logos and slogans. Try to include the logos and slogans of local recycling centers and organizations.

2. Discuss how these logos and slogans represent the values of the product or organization being promoted.

3. Summarize the values of logos and slogans. For example:
    a. They attract attention.
    b. They promote a program with simple symbolism.
    c. They stimulate instant recall.
    d. They are attractive.
    e. They enhance feelings of identification with the program.

4. Discuss the values the students want their logos and slogans to promote.

5. Draw the logos and write the slogans.

6. Choose the favorite logo and favorite slogan. Reproduce them in poster form and display the posters in the school, community, and recycling center.

Goal:
Students will create a slogan and design a logo for posters promoting the school's recycling program.

School Subject:
Art, Advertising

Grades:
4th - 12th

Time:
1 class period and outside assignment

Materials:
- Examples of advertising slogans and logos

Adapted from ***A-WAY WITH WASTE, 1985***

TAKE-HOME RECYCLING KIT

PROCEDURE

1. Assemble the "Take-Home Recycling Kit":

   a. Have students cut cardboard into five 8 1/2" x 11" pieces.
   b. Glue different colored sheets of construction paper to one side of each cardboard piece.
   c. Have students label the top of each piece of construction paper using the following headings: Glass, Paper, Aluminum, Tin.

2. Using the following "How to Recycle Sheet", do one of the following:

   a. For younger students - photocopy the sheet for each student. Have them cut the copied sheets on the dotted lines and paste the pertinent information on the bottom of the appropriate card.
   b. For older students - give them the copied sheet and have them transfer the information in a creative manner.

3. Using the magazines, cut out pictures of the different categories of waste. Paste these pictures below the label and above the directions on the corresponding cardboard sheets to form collages. In making the aluminum card, use aluminum foil brought from home.

4. Ask students to label the remaining sheet "Recycle".

5. Photocopy the "How to Set Up Your Home Recycling Center" sheet for each student.

6. Read and discuss with students how they might set up centers in their homes. Paste this copy on the "Recycle" sheet.

7. Have students draw a floor plan of their home and property, marking places where they could set up home centers. Paste this plan on the back side of the "recycle" sheet.

8. Have students punch two holes on the right hand side of "recycle" sheet, two holes on both

Goals:
Students will be able to:
- help solve home and community waste problems by constructing a take-home recycling kit.
- explain to their families and community groups the whys, whats, and hows of home source separation.

School Subjects:
Social Studies, Language Arts, Art

Grades:
3rd - 6th

Time:
2 - 3 class periods

Materials:
Students:
- A ***used*** cardboard box or five 8.5" x 11" pieces of cardboard, magazines, a piece of ***used*** foil and ***used*** ribbon or twine.

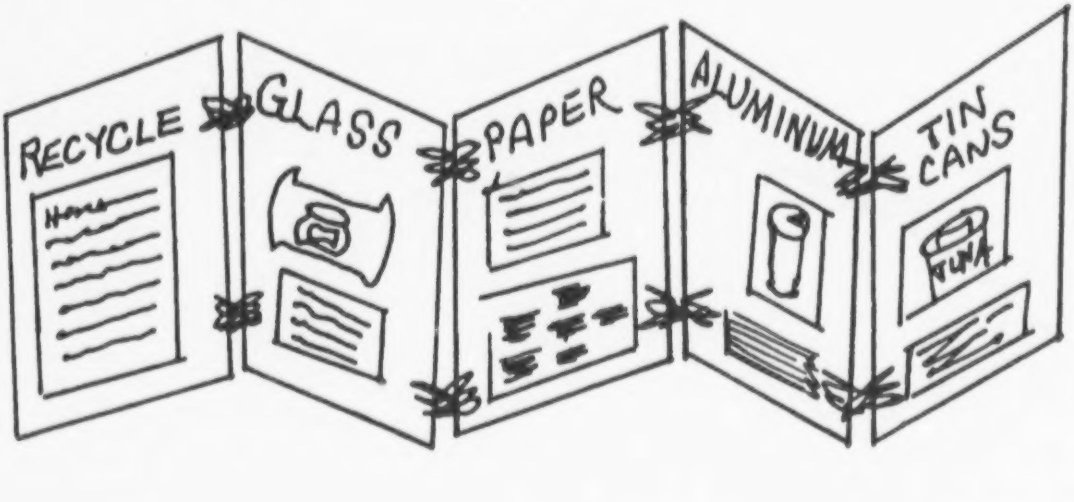
Teachers:
- Marking pens, glue, scissors, hole punch, variety of colored construction papers

sides of the "paper", "glass", and "aluminum" sheets and two holes on the left side of "tinned cans" sheet. Connect the sheets with ribbon or twine.

9. Presenting the kit:

   a. In preparation for teaching their families, have students in class practice in groups. Each group discusses various approaches and selects one group member to present his or her kit to the class. Following presentations, discuss which approach might be most successful. Students practice their presentations in pairs until they understand and can effectively communicate the information to each other.

   b. Have students present their kits to their families and report back in class on the reactions to their presentations.



Adapted from ***A-WAY WITH WASTE, 1985***

How to Recycle Glass

As much as possible, buy returnable or reusable bottles. To prepare glass for recycling, do the following:

1. Wash glass - no need to remove labels.
2. Check with recycler to see if it is necessary to remove all metal caps and rings. Discard caps.
3. Separate glass containers by color, either at home or at the recycling center.

How to Recycle Paper

Newsprint

1. Stack newspapers in a fire-safe area.
2. Check with recycler to see if newspapers should be tied in stacks, or put in paper bags.

Other Papers

Corrugated cardboard:	(two layers of heavy cardboard with a ribbed section in between). Check with your recycler. Flatten for easy storage and transportation. Store in fire-safe area.
Hi Grades:	(this is computer paper, tab cards, and edger paper.) Check to see what types of paper your recycler accepts.

How to Recycle Aluminum

1. Check to make certain the cans are all aluminum.
2. Rinse. (You may wish to flatten to save storage and transportation space.)
3. Separate aluminum cans from other aluminum products; i.e., TV dinner trays, foil, etc.

How to Recycle Tinned Cans

These are typical food cans - 1% tin, 99% steel.

1. Wash them out and remove labels.
2. Remove both ends and flatten.

How To Set Up Your Home Recycling Center

Setting up and maintaining your home recycling center can be a fast, easy process. The time required per household is about 73 minutes per month - a little more than 2 minutes per day.

The following are the basic steps for establishing your home recycling center:

1. Find a convenient place in your home or apartment for the center. It doesn't take much room - storage of glass, cans and newspaper for a month usually takes a 3 x 3 foot area. The garage, a storage closet, corner of the kitchen or under the sink are good places.

2. Find sturdy containers to store materials. Three plastic buckets or paper boxes can be used: one for paper, one for cans and one for glass.

3. Locate your closest recycler. Check your Yellow Pages. Find out:
   a. if the recycling center is a donation or buy back center
   b. what materials the center will take
   c. how you should prepare the recyclables before you bring them in
   (e.g., some recyclers require that cans be crushed before you bring them in).

HAZARDOUS WASTE

BACKGROUND INFORMATION

Disposing of hazardous wastes in a manner that will keep them sealed away forever is a very difficult if not impossible task. The necessity of controlled and careful disposal of hazardous wastes has only been recognized in the last 15 years. For years the disposal of hazardous wastes was not regulated by the government. Many wastes were carelessly disposed of in landfills, ponds, or lagoons. Drums of highly toxic substances were disposed of by clandestine operations commonly referred to as midnight dumping. The light of day has revealed dump sites along country roads, in abandoned warehouses, and in fields across the country. The EPA estimates that as of October, 1984, 18,000 potentially hazardous waste disposal sites exist in the United States.

The improper management of hazardous waste can be disastrous to the environment and to public health. Destruction of the environment may take many forms - groundwater and water supply contamination, wildlife habitat destruction, soil contamination, fishkills, livestock loss, air pollution, fire, explosion, and crop damage. Danger to health may be directly related to these environmental effects, but is often more subtle, even undetectable in early stages.

Some of the most troublesome hazardous substances are synthetic organic chemicals. These materials can be highly toxic and some are not easily biodegradable. Many tend to persist in the environment and to accumulate in the fatty tissues of animals. When these animals are eaten by humans or other animals, the chemicals stored in their bodies are transferred. Such substances are eliminated very slowly by normal body functions and processes, and accumulation proceeds with continued uptake. Whether through ingestion, inhalation, or skin contact, the buildup of these substances can be so dangerous that some chemicals have been banned in the United States.

The first step in dealing with abandoned disposal sites is to identify the types of wastes present and determine the potential health risks posed by the hazardous wastes. A hazardous waste is defined by Congress as 'discarded material that, when improperly managed, may pose a substantial threat or potential hazard to human health or the environment'. In the form of solids, liquids, sludges, or contained gases, these wastes differ from other by-products by fitting into any of the following categories:

Toxic: Wastes containing substances that can cause damage to human health or the environment. Toxic wastes include inorganic toxic metals, salts, and acids or bases, including compounds containing lead, mercury, and arsenic. They also include synthetic organic chemicals such as the insecticides DDT, DDE, or endrin; herbicides such as 2,4,5-T and other chlorinated hydrocarbons and PCBs.

Ignitable: Materials prone to spontaneous combustion while being transported or stored. Examples: organic solvents such as benzene, varnish, and paint removers; oil.

Reactive: Wastes having a tendency to explode or generate toxic fumes when exposed to heat, air, water, or shock. Examples: obsolete munitions and by-products of explosives and chemical industries.

Corrosive: Substances having the ability to corrode or eat away materials, or ones that can burn or irritate skin. Examples: battery acid, acid liquids used in etching, alkaline cleaners.

Wastes with any of these characteristics are now subject to regulation under the ***Resource Conservation and Recovery Act (RCRA)***. Radioactive wastes which also pose serious health risks are managed by the Nuclear Regulatory Commission.

The RCRA was created in 1976 (amended in 1984) giving the EPA authority to monitor hazardous wastes from "cradle-to-grave" or from the point of generation to ultimate disposal. The EPA is still in the process of issuing permits to waste storage and disposal sites that meet the new standards. This legislation has been enacted to prevent haphazard disposal of wastes. It does not cover past disposal problems. To deal with the enormous task of cleaning up the tons of improperly disposed hazardous wastes, a Superfund program was created by Congress in 1980.

Superfund was established by the ***Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)***, which in 1980 provided the EPA with $1.6 billion to clean up abandoned hazardous waste sites. 86% of the fund was financed by taxes on the manufacture or import of certain chemicals and petroleum. EPA lists 786 Superfund sites around the nation. Only 12 of these sites have been fully cleaned; perhaps as many as 2,500 sites could be added to the list at a cost of approximately $23 billion. Cleaning up Superfund sites usually involves trucking the wastes to approved land disposal sites. However, this may provide only a temporary solution to the problem since there is much uncertainty about our ability to permanently dispose of hazardous wastes in an environmentally sound manner.

The Department of Health Services, Toxic Substances Control Program is the agency in California that regulates the treatment, storage, disposal and transportation of hazardous wastes. The mission of the Toxic Substances Control Program is to work with government, the public and industry to reduce, manage and eliminate hazardous waste for a healthier, safer, cleaner and prosperous California. The Toxic Substances Control Program accomplishes this through its Permitting, Surveillance and Enforcement, Site Mitigation and Alternative Technology programs.

Land disposal is currently the most economically feasible method of hazardous waste disposal, but it is fraught with problems. There is general agreement that to adequately tackle our hazardous waste problem we need to reduce the waste stream and implement alternative technologies to neutralize, solidify, recycle, and detoxify hazardous materials. Research to perfect these technologies and to bring their costs down is currently underway.

Sources: ***LIVING LIGHTLY ON THE PLANET, 1987 and WASTE: A HIDDEN RESOURCE, 1989***

BIKES AND BY-PRODUCTS

BACKGROUND

Hazardous means dangerous. Hazardous wastes are likely to cause harm to the environment or to humans because they are either toxic (poisonous), flammable (ignitable, highly burnable), reactive (explosive), or corrosive (substances that rapidly eat into and/or dissolve what they touch).

Goals:
Students will learn what the term "hazardous waste" means and will learn some of the hazardous wastes created by the manufacturing of a bicycle.

School Subject:
Science, Social Stud

Grades:
3rd - 6th

Time:
1 - 2 class periods

Materials:
- A bicycle
- Copy of bicycle materials sheet

PROCEDURE

1. **Ask the class:** How many of you have bicycles? Of what are they made? What are the frames made of? How about the tires? The handle bar grips? Where are the metal and rubber and plastic that go into bicycles made? (In mills and factories that transform raw materials such as petroleum, bauxite and iron ore into bicycle components.)

Ask: What makes your bike special - different from others? How many different colors of bikes do we have? Whose bike is shiny? What is the shiny metal on bikes called?

Ask: Which natural resources are used in the making of bikes? (iron; petroleum for plastics, synthetic fibers and synthetic rubber; petroleum distillates for paint and paint solvents; bauxite for aluminum; chrome; coal for coke to smelt the iron ore into steel and others.)

Ask: What had to happen to the natural resources before they could be used to build your bike? (They had to be processed in factories.) Direct the discussion from here with the aim of having students realize that when natural raw materials are processed, by-products and waste, some of which may be harmful, are produced.

Ask: What are by-products? For example, what by-products are produced when you burn wood and paper in your fireplace or woodstove at home? Are some of these by-products harmful? What kinds of things might be by-products of the building of your bicycle?

2. **Distribute** the manufacturer's accompanying diagram of a bicycle that lists some of the materials and by-products associated with the manufacturing of bikes or ask a student to bring his or her bike to class. In the latter case, have students make their own diagrams of the bike. Guide students in identifying the bike's component materials (steel, synthetic rubber, plastic, chrome, synthetic fibers, aluminum, paint, etc.) Then, by referring to the diagram, point out some of the by-

products and wastes resulting from the manufacturing of these components.

3. **Explain:** Some (of course, not all) of the by-products and wastes from making a bike are hazardous. What does hazardous mean?

Ask: Does this mean that you will get sick from handling or riding your bike? Why not? What happened to the hazardous by-products and wastes produced when your bike was made? (Note: some are captured and recycled for industrial use. Some are captured and disposed of in hazardous waste disposal sites. Some escape into the air and water, some are sent to conventional landfills and some are dumped illegally.)

Ask: How should hazardous wastes and by-products be managed? Why is it important to use great care in disposing of these wastes and by-products?

Ask: Because hazardous wastes and by-products are made when bikes are built, should we stop making bikes? What should we do that makes more sense? What are some other things you use that might also have produced hazardous by-products when they were made?

4. **Discuss:** Why has there been so much news about hazardous waste lately?

Adapted from ***A-WAY WITH WASTE, 1985***

By-Product & Waste Information From *Liquid Waste of Industry*

Nelson L. Nemerow, Addison-Wesley Pub. Co., Menlo Park, CA, 1971

Chrome & Plated Metal Parts

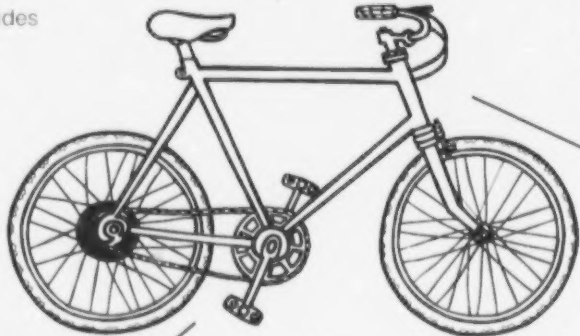
Materials
Chrome, nickel, copper, zinc

By-Products & Waste
(Highly toxic liquid wastes)
Acids, chromium, zinc, copper, nickel, tin, cyanides

Handle bar grips, plastic seat cover, paint, synthetic fibers, synthetic rubber tires

Materials
Petroleum & petroleum distillates

By Products & Waste
Waste oil from leaks, caustic & acid sludge, alkaline & acid waters, acid gases & filtering clays



Frame & Other Metal Parts

Materials
Iron ore & coal to make steel

By Products & Wastes
Ammonia, tar, acids (pickling liquor waste), blast furnace flue dust

Paints & Coatings

Materials
pigments
solvents
resins
cleaners

Wastes
paints
solvents
cleaners

Fenders & Other Metal Parts

Materials
Aluminum from bauxite

By Products & Wastes
Large volumes of "Red Mud" consisting of zinc oxide, titanium & silica

THE LEGACY OF LOVE CANAL

BACKGROUND

In 1980 President Carter declared Love Canal in Niagara Falls, New York, a federal emergency area. That proclamation marked the first time in history that a federal disaster was declared as a result of human actions. It also marked the beginning of our growing awareness of the risks associated with hazardous waste disposal.

Love Canal is one of thousands of sites where hazardous wastes have been disposed. EPA has disclosed that as of 1980, 90% of hazardous wastes have been disposed of by environmentally unsound methods, mostly in unlined landfills. Of the 10% of wastes that were disposed properly, some are in secure landfills, some have been incinerated under controlled conditions, and others have been recycled or recovered.

The aim of this activity is to expose students to the problems related to hazardous waste disposal and the laws regulating handling, transporting, and disposal of hazardous wastes.

Goals:
Students will:
- describe how hazardous wastes can leach into soil and groundwater.
- describe how human health and the environment were damaged by chemicals that leached from the Love Canal site.

School Subject:
Social Studies, Science.

Grades:
10th - 12th

Time:
1 class period

Materials:
- Student worksheet
- "Legacy of Love Canal" handout

PROCEDURE

1. Ask students if they are aware of the Love Canal case. Distribute the case study for them to read.

2. When students have had an opportunity to read the case study, have them form discussion groups. Have them complete the Student Worksheet.

3. Ask students to describe how hazardous wastes moved from their containers at the Love Canal site into soil and groundwater. They should be aware that containers with corrosive wastes can be worn away. Rainwater seeps into an open container and through a cracked landfill cap, causing hazardous wastes to leach into soil and groundwater.

4. What can we do to prevent future Love Canal incidences? Introduce the students to the Resource Conservation and Recovery Act (RCRA), and the Superfund or Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the California Department of Health Services, Toxic Substances Control Program covered in the introduction to this unit.

THE LEGACY OF LOVE CANAL

A Case Study
Student Information Sheet

The once thriving neighborhood in the Love Canal section of Niagara Falls, New York, now looks like a boarded-up ghost town. The empty streets and abandoned homes are silent testimony to the dangers posed by improper hazardous waste disposal.

Love Canal, named for William T. Love, is a half-mile trench. Love had the trench dug during the 1890s as part of an industrial project to channel water from the Niagara River. The project failed but the trench remained. Over the years the trench or canal became a disposal site for chemical wastes. During the 1940s and early 1950s the Hooker Chemical Company buried 21,800 tons of wastes in the abandoned canal. Most of the wastes were contained in steel drums. They were then buried in clay to seal them off from rainwater.

The canal site was sold by Hooker Company to the local school board for $1. A school was built on the land and a neighborhood developed around it. But even the bargain price tag would not have attracted buyers if anyone had known that the dump site was like a ticking environmental time bomb ready to go off.

When the school and homes were built the construction of the underground utilities may have damaged the clay cap over the landfill. Cracks in the clay allowed snow and rainwater to seep into the Love Canal and overflow. The chemicals, some of which had corroded through steel drums, then began oozing to the surface and seeping into the basements of unsuspecting homeowners nearby. Some chemicals leached into soil and groundwater and made their way into nearby streams.

Community residents began to notice noxious fumes and pools of thick black sludge on the ground. Some school children began to complain of rashes and respiratory problems. Eight-year-old Jon Kenney used to play in a neighborhood creek with his friends. Traces of the deadly chemical dioxin were found in the creek. Jon Kenney died of kidney failure. Kidney and liver problems as well as increased miscarriages and birth defects all began to come to the attention of government and health authorities. As news of health risks mounted, many residents became convinced that their health was endangered. Some residents like Jim and Ursula Clark tried to sell their homes. But they couldn't attract any buyers, even after offering their $50,000 home for $1.

In August of 1978, the New York State Health Department investigated the area. They found 82 chemicals, including a dozen potentially carcinogenic or cancer-causing substances. They declared a health emergency for the 240 homes bordering the canal. The families were relocated, their homes were purchased by the government, and work to contain the oozing chemicals was begun. These measures cost state, federal, and local agencies more than $27 million.

Unfortunately, the chemical leaks did not stop at the homes directly bordering the canal. An informal study conducted by the EPA found that 11 of 36 Love Canal residents tested had developed chromosome damage. This kind of damage is linked to birth defects. The methods of the study were criticized by researchers because they did not compare blood samples with people living outside the Love Canal area. But the high incidence of miscarriages and birth defects was alarming. Of the fifteen babies born to Love Canal families between January 1979 and January 1980, the Love Canal Homeowner's Association reported that only two were normal. The others had birth defects or were stillborn.

Many of the residents remaining in the neighborhood were frightened and frustrated. They wanted to move but knew that no one would buy their homes. Jo Ann Kott, a Love Canal resident who had suffered a miscarriage and a stillbirth, claimed: "I want a fair market value for my house and to get this nightmare over with." The Love Canal Homeowner's Association president, Lois Gibbs, sent a telegram to President Carter: "Don't let our people get lost in a sea of red tape as we watch our babies fighting sickness and growing up into an uncertain future." The distraught residents also held two EPA officials "hostage" for six hours in the Association's headquarters to draw attention to their plight.

President Carter responded by declaring the neighborhood covering six blocks from the canal as a federal emergency area in May of 1980. Four hundred more families were then evacuated. Their homes were boarded up and purchased with state and federal funds. Several lawsuits were filed against the Hooker Chemical Company. Their outcome will determine who will pay the costs of buying the homes, cleaning up the canal, and caring for the families.

What will become of the Love Canal neighborhood? The school and 227 homes near the canal have been demolished. Plans to have people move into some of the empty homes remaining are underway. In an attempt to make the area safe, the canal has been capped with a new layer of clay. Trenches with drainage pipes have been built on both sides of the canal to capture chemically contaminated leachate.

But safety is still a major concern. In 1982 the federal government declared that houses more than a block and a half away from the canal were safe to live in. But a year later chemicals were discovered to be leaking from the canal and resettlement plans were put on hold. When and if the area will be safe is still unknown. A more frightening unknown concerning families who fled the Love Canal is what the long-term health effects will be for themselves and children yet to be born.

THE LEGACY OF LOVE CANAL
Student Worksheet

1. If you had been forced to abandon your home at Love Canal, what would you want the government to do: clean up the site and allow you to move back in or permanently seal off the site and pay you fair market value for your home?

2. Who should have been responsible for paying the cost of relocating the families, their health costs, and the cleanup of the Love Canal? Where do responsibilities of the Hooker Chemical Company end and the responsibilities of the school board who bought the property begin?

3. A tentative multi-million dollar agreement to settle property and health damage claims of 1,325 Love Canal residents was reached with Hooker's parent company, Occidental Petroleum Corporation, on October 10, 1984. The EPA has spent nearly $45 million under the Superfund program to clean up the Love Canal. The Justice Department, on behalf of the EPA, has sued Occidental Chemical Corporation for $45 million to recover the costs. Do you think Occidental Chemical Corporation should have to pay this $45 million?

4. Look in the Readers' Guide to Periodical Literature under Love Canal. What is the current status of the site?

5. The government was anxious to resettle the Love Canal area so that a costly trend of abandoning areas around dump sites did not gain momentum. If the estimated 18,000 abandoned chemical dump sites in the United States all required settlement on the scale of Love Canal, the costs would be enormous. Who should pay those resettlement and cleanup costs if the companies responsible for improper waste disposal can't be identified?

6. 86% of the Superfund law that currently helps to pay cleanup costs for abandoned dump sites is funded by chemical companies. Chemical companies are lobbying Congress to lessen this contribution, which comes from taxes they pay on chemical ingredients. Additional revenue would then come from federal taxes paid by the general public. Where do you think the Superfund monies should come from?

Adapted from ***LIVING LIGHTLY ON THE PLANET, 1987***

HAZARDOUS WASTE IN MY HOME TOWN?

BACKGROUND

All businesses, large and small, generate waste. Some of this waste is hazardous. The hazardous wastes produced by large firms in the chemical, pulp and paper, steel and aluminum industries are obvious, but many small businesses that are found in every community also generate hazardous wastes. These include such operations as auto body repair shops and dry cleaners. "High-tech" companies that manufacture computer chips and electronic circuits are often thought of as "clean" industries. However, they too, produce sometimes large quantities of hazardous by-products. Many of these by-products are fouling groundwater and adversely affecting human health, the health of other organisms, and the quality of the environment.

Huge amounts of waste are generated. For instance, over 1,000 bulk chemicals go into the production of an automobile. Many of the by-products are hazardous wastes. Paints, pesticides, plastics - the list of products that generate some type of hazardous by-products goes on and on. This gross national by-product amounts to 264 million tons of hazardous wastes produced annually in the United States. The amount of hazardous garbage would fill the New Orleans Superdome almost 1,500 times over.

Goals:
Students will:
- identity the number and kinds of local commercial and industrial waste generators.
- identify ways they benefit from products or services that produce hazardous waste.
- learn where they can get information about hazardous waste.

School Subject:
Social Studies, Geography, Economics, Environmental Studies.

Grades:
7th - 12th

Time:
1- 4 class periods

Materials:
- Local yellow pages
- Overhead: "Hazardous Substance Characteristics"
- Overhead: "Some Industrial & Commercial Hazardous Waste Categories" (blank worksheet & answer key)
- Map of the community
- Handout: "Businesses Generating Hazardous Waste"

PROCEDURE

1. Ask students to think of as many different kinds of businesses and industries in your area as possible. Use the yellow pages, or ask your Chamber of Commerce for information. Make sure that both large and small businesses are included. As local businesses and industries are identified, have students describe what products or services these enterprises provide. Tabulate the number and kind of industries on the board.

Discuss: How do these products or services benefit us? (For example: Dry cleaners clean our sweaters, suits; automotive body shops repair or customize our cars; printing shops prepare brochures, flyers, newspapers, etc. that keep us informed.)

Discuss: How does the industry staff contribute to the economic well-being of the community? What does the community contribute to the industry? What responsibilities does each have to the other? What would happen if these industries were not able to operate in the community?

2. **Ask:** What wastes might be produced by these local businesses and industries? How are these wastes managed? What precautions were taken by the industry concerning its hazardous waste? (If the wastes aren't hazardous, they are either recycled, go to a landfill, or are released into the sewage system for treatment. If they are hazardous they may be stored or treated on-site.)

3. **Ask:** What qualities would make a waste hazardous? Show and discuss the overhead "Hazardous Substances Characteristics", so that students understand the four basic characteristics of hazardous waste. Ask: Under what conditions can a hazardous waste pose a threat to human or animal life? (Persistent substances can last a long time in the environment before being broken down into something less hazardous; long term exposure to certain substances at low levels; bioaccumulation of substances; synergistic effects; heightened sensitivity of certain groups of people to specific substances such as young children to lead, a heavy metal.)

4. Distribute copies of the handout, "Businesses Generating Hazardous Waste". Ask: Did we find any of these kinds of businesses in our community?

5. Pass out copies of the blank "Industrial & Commercial Waste Categories" sheet. Ask students to match the categories with the hazard characteristics discussed above, by filling in the "blank" column. Explain that any category may have more than one characteristic, be persistent or affect certain subgroups of people. Ask students to think of as many ways wastes might cause harm. This can be done individually or in groups using brainstorming techniques. Give students 10 minutes or so to work on their answers. Ask: How can we find out more about the hazardous wastes generated in our community?

6. Identify a local number that is a good source of information about hazardous wastes. To find these, consult your telephone book and look under local and state agencies. In California, call the Toxic Substances Control Program of the California Department of Health Services. Discuss the principle that all citizens have a right to know about hazardous substances in their community.

7. **Ask:** What are some of the ways wastes can enter the environment? Distribute maps of your town or county, or have students draw maps. Have students locate and mark the local landfill and sewage treatment plant. Have them highlight streams, lakes and salt water.

8. Using a list of businesses, have students mark the locations where hazardous wastes might be produced on their maps. When maps are complete, ask: Which areas in our town or county are most vulnerable or sensitive to pollution? (Aquifers and wetlands, for example.) Is hazardous waste generated near any of these sensitive areas? Have we identified all the hazardous waste generators in our area? How can we find out? How can we get more information about hazardous waste?

9. **Ask:** What can we do to prevent pollution? How can we ensure that our environment does not endanger human or animal health due to hazardous wastes in our communities? Explain to students that to protect public health and the environment, hazardous waste is managed by a system much stricter than for non-hazardous waste.

DISCUSSION/TEST QUESTIONS

What characteristics make waste hazardous?
Name 3 types of small businesses that generate hazardous waste.
From whom can you learn more about hazardous waste?

Adapted from ***A-WAY WITH WASTE, 1990 and LIVING LIGHTLY ON THE PLANET, 1987***

SOME INDUSTRIAL & COMMERICAL HAZARDOUS WASTE CATEGORIES

Worksheet

Waste Category	Hazard Characteristic(s)	Other Considerations
Acids/Bases		
Cyanide Wastes		
Filtration Residues		
Formaldehyde		
Heavy Metals and Inorganics		
Ink Sludges		
Oils (used)		
Pesticides		
Preserving Agents		
Solvents/ Degreasers		
Spent Plating Wastes		

Source: **A-WAY WITH WASTE, 1990.**

SOME INDUSTRIAL & COMMERICAL HAZARDOUS WASTE CATEGORIES

Answer Key

Waste Category	Hazard Characteristic(s)	Other Considerations
Acids/Bases	Corrosive, Reactive	Can sometimes react violently with water
Cyanide Wastes	Toxic	
Filtration Residues	Corrosive, Reactive, Toxic	
Formaldehyde	Toxic	Sensitive populations (1)
Heavy Metals and Inorganics	Toxic	Persistent; sensitive populations (2)
Ink Sludges	Toxic	Persistent; sensitive populations (2)
Oils (used)	Toxic	Persistent; sensitive populations
Pesticides	Toxic	Persistent (3)
Preserving Agents	Toxic, Corrosive	
Solvents/ Degreasers	Corrosive, Reactive, Ignitable, Toxic	Sensitive populations (1)
Spent Plating Wastes	Corrosive, Toxic	

1. Some individuals are especially sensitive.
2. Children are especially at risk to lead exposure.
3. Chlorinated pesticides can bioaccumulate.

Source: ***A-WAY WITH WASTE, 1990.***

BUSINESSES GENERATING HAZARDOUS WASTES

Type of Business	Hazardous Wastes Generated
Auto Repair and Maintenance	Lead-Acid Batteries Heavy Metals Solvents Acids/Bases Used Oils
Building Cleaning and Maintenance	Acids/Bases Solvents
Cleaning Agents and Cosmetics	Acids/Bases Heavy Metals/Inorganics Solvents
Electric and Computer Chip Manufacturers	Acids/Bases Spent Plating Wastes
Farmers and Agricultural Service Shops	Pesticides Solvents Used Oils
Furniture/Wood Manufacturing/ Refinishing	Solvents
Laundries and Dry Cleaners	Dry Cleaning Filtration Residues Solvents
Motor Freight Terminals and Rail Transport	Acids/Bases Lead-Acid Batteries Heavy Metals/Inorganics Solvents Used Oils
Printing Industries	Acids/Bases Heavy Metals/Inorganics Ink Sludges Spent Plating Wastes
Schools, Labs and Vocational Shops	Acids/Bases Solvents Heavy Metals/Inorganics
Wood Working (Boat builders, lumber mills, etc.)	Preserving Agents

Source: ***A-WAY WITH WASTE, 1990.***

HAZARDOUS SUBSTANCE CHARACTERISTICS

TOXIC

A substance that is potentially harmful to human health, can cause cancer or birth defects, and can contaminate, harm or kill fish or wildlife.

Examples: Lead, mercury, pesticides.

REACTIVE

An unstable substance that reacts strongly (including explode) if exposed to heat, shock, air, or water.

Examples: Bleach and ammonia when mixed together; munitions.

CORROSIVE

A highly acidic or base substance that corrodes storage containers or damages human tissue if touched.

Examples: Battery acid, bathroom cleaners, pool chemicals.

IGNITABLE

A substance that can explode, catch on fire, or emit toxic fumes or gases into the environment.

Examples: Fuels, some cleaning fluids, some furniture polishes.

CALIFORNIA DEPARTMENT OF HEALTH SERVICES, TOXIC SUBSTANCES CONTROL PROGRAM

IS MY BUSINESS YOUR BUSINESS?

Goal:
Students will:
- gain an appreciation of the hard choices involved in conducting a business.
- understand the concepts of short-term and long-term gains and losses.

School Subject:
Social Science, Science, Math.

Grades:
5th - 7th

Time:
2 class periods, plus optional project

Materials:
- Business Costs Worksheets, supplies for a Kool-Aid stand (optional project), such as a table or stand, a table covering, cups, flavoring or fresh fruit juice, sweetner, etc.

PROCEDURE

1. Write the number 300,000,000,000 on the board. Ask students how large they think this number is. Is it bigger than the number of people in our country? The world? What does it represent?

2. **Say:** This represents the dollars some people think we need to spend to clean up all the dumping grounds in this country containing substances harmful to humans and wildlife. Ask: Where did these dumps come from? (Mostly from industries that manufacture products that we use every day such as cars, toys, paper, etc.)

3. **Ask:** Where will the money come from to clean up these dangerous dumps? Who should pay to make the sites safe again? (The companies responsible? The people closest to the dumps? Government taxes on some businesses?)

4. **Ask:** Why did companies dump dangerous substances? (It's cheaper, easy to do, no laws against it, didn't know about danger, a better product could be manufactured, etc.) Can companies still do this now? (No, there are federal and state laws against putting hazardous substances into dumps.)

5. Today federal and state laws prohibit disposing of hazardous substances into dumps. Businesses must factor the high cost of hazardous waste disposal and management into their cost of doing business. Some businesses do not produce hazardous waste themselves but use products which created hazardous waste when they were made. Conscientious business persons might also consider the environmental impact of the manufacturing process of products they use in their business and may be willing to purchase higher priced items for lower impact during production. There is of course less incentive to consider these impacts because they do not cost the company directly. **Ask:** If you were a business person, would you be willing to pay more for a product if its manufacture did not produce harmful by-products? What if your business was only making a small profit and a cheaper but more harmful product was available?

6. List some businesses and ways that students can earn money on the board, such as a juice or Kool-Aid stand, yard cleaning service, car washing service, a neighborhood newsletter, recycling program, etc. Have students suggest other busi-

nesses they think they could start or other ways they might propose to earn money.

7. Decisions regarding which products to use and sell in business are among the many tough issues a business person must consider.

Ask: What kind of information do we need to plan a business? (The product or service the business will offer, the costs involved in offering the product or service and the price the product or service will be sold at in order to make a profit.)

Ask: What kind of questions should we ask to make sure our products or the things we use to provide a service do not harm the environment? (Is the supply or product recyclable? Does it break down so it will not harm the environment in the future?) Remind the students that even though a product may not harm the environment, the process of making the product may have produced harmful wastes.

8. Tell the students sometimes an environmental checklist is necessary to help a business person assess the environmental impact of the many potential products he might use or produce. Tell students they are now going to consider the choices involved in running a business. Hand out the Business Costs worksheet for the Kool-Aid or Juice stand. Give students five to ten minutes to fill out as best they can the environmental checklist for supplies.

Ask: Which types of drink flavoring would be best in terms of environmental safety? Which types cost the most? Which should we choose to make the biggest profit? Which should we choose to cause the least harm to our environment in the future? Are they the same?

Ask: Which type of cup should we choose as safest for the environment? What type of cup is easiest to use? Which cup keeps the drinks the coolest? What cup should we choose to make the biggest profit?

Ask: What do you think your customers would choose? How can you find out? (Market surveys, questionnaires) Do you think your customers would be willing to pay more if they knew that the products were environmentally safe?

Ask: What would you do if a Kool-Aid stand opened down the street and sold its drinks for less than your price? Would you buy different supplies?

Adapted from ***A-WAY WITH WASTE, 1990***

Business Costs - Worksheet

Business Name

Owner/Operator ______________________

Product/Service

		Environmental Checklist			
Name of Supply	**Choices**	**Packaging (Glass, Metal, Paper, Plastics)**	**ReUse Recycle Compost**	**Dangerous Wastes or By-Products**	**Cost for a single item (8 oz. serving)**

Source: **A-WAY WITH WASTE, 1990.**

Business Costs - Worksheet

			Environmental Checklist		
Name of Supply	**Choices**	**Packaging (Glass, Metal, Paper, Plastics)**	**ReUse Recycle Compost**	**Dangerous Wastes or By-Products**	**Cost for a single item (8 oz. serving)**

Source: **A-WAY WITH WASTE, 1990.**

Business Costs - Worksheet

Business Name *Keep Kool Juice Stand* **Owner/Operator** ____________________

Product/Service *Fruit/Juice Drink (8 oz. size)*

			Environmental Checklist		
Name of Supply	**Choices**	**Packaging (Glass, Metal, Paper, Plastics)**	**ReUse Recycle Compost**	**Dangerous Wastes or By-Products**	**Cost for a single item (8 oz. serving)**
Flavor	Fresh Grapefruit				$.61
	Fresh Orange				$.86
	Fresh Lemons				$1.08
	Frozen Concentrated Orange/Lemon				$.22
	Grape (bottled or frozen)				$.13
	Powders: Kool-Aid Lemonade				$.01-.03

Source: **A-WAY WITH WASTE, 1990.**

Business Costs - Worksheet

		Environmental Checklist			
Name of Supply	**Choices**	**Packaging (Glass, Metal, Paper, Plastics)**	**ReUse Recycle Compost**	**Dangerous Wastes or By-Products**	**Cost for a single item (8 oz. serving)**
Cups	Papers				$.03
	Plastic: Clear Colored				$.05
	Styrofoam				$.02
	Glass				$.25-.75
Table or Stand Covering	Cloth				$5.00-10.00
	Paper				$2.00-3.00
	Plastic				$5.00-6.00

Source: **A-WAY WITH WASTE, 1990.**

TRADING TOXICS

Goals:
Students will:
- understand how reducing and recycling hazardous wastes can be both economically and environmentally sound
- know what a waste exchange is

School Subject:
Social Studies, Science, Health Education.

Grades:
9th - 12th

Time:
2 days

Materials:
- Overhead or handout "Businesses Generating Hazardous Wastes"
- Industrial and Commercial Hazardous Wastes Categories handouts

BACKGROUND

Waste can be reduced in a number of ways. One way is to prevent its production in the first place. North Carolina's Pollution Prevention Pays program is an example of a pioneer governmental effort to assist businesses with hazardous waste reduction. By offering technical help to companies trying to prevent wastes in the manufacturing process, businesses and industries learn that cutting hazardous waste generation can actually save them money. Grants for waste prevention research and education are also funded.

Waste exchanges are another way to prevent or reduce hazardous wastes. Most exchanges are non-profit information clearinghouses. They list wastes available from various firms, make this information available, but do not take part in transactions. Many of these exchanges are government sponsored. Other exchanges are run for profit by private entrepreneurs who function as brokers. These firms receive a fee for each exchange transaction.

Amendments to federal laws now require companies to be strictly responsible for all the hazardous wastes they generate no matter how they are managed. Disposal in a landfill does not absolve a firm of this responsibility. Thus firms are now finding waste exchanges economically attractive alternatives. For example, the Northeast Industrial Waste Exchange in Buffalo, New York reported that over a million dollars worth of waste materials were exchanged in 1985. This is nearly six times the amount exchanged in 1984. Other exchanges also report similar increases.

The California Department of Health Services operates the California Waste Exchange. They publish a directory of Industrial Recyclers and a Waste Exchange Newsletter/Catalog. The Newsletter/Catalog includes listing of hazardous wastes wanted and hazardous wastes available for recycling.

PROCEDURE

1. Review the problems with hazardous waste disposal in landfills or its destruction in incinerators.

2. **Ask:** What can industries do to reduce the amount of hazardous waste they generate?

(Change the manufacturing processes; recycle spent or used material; find other companies that can use the wastes.) List the responses on the board. Tell students that both Fedetal and State waste management priorities emphasize hazardous waste reduction and recycling.

3. Distribute the handout, "Businesses Generating Hazardous Waste" **Ask:** Are there any wastes on this list that might be used by other industries? (Acids and bases are used by pulp and paper mills, steel mills and many other industries; solvents are used by a variety of manufacturers.)

4. Explain how waste exchanges work. Tell students that California has waste exchanges. Two examples of exchanges are: 1) Lignon, which is a waste material from pulp mills, is used by chemical manufacturers in the production of vanillin, the substance that gives artificial vanilla its taste. 2) Chrome acid is used for plating metals. The chrome on your car or bicycle may have generated this hazardous chrome waste. The spent solutions are being used by pulp mills in the manufacture of paper.

5. **Ask:** Why would a company use a waste exchange? (Reduce storage space and save money; reduce disposal fees; reduce costs of supplies and substances used in manufacturing products; avoid violating the law in disposal of wastes; reduce transportation and/or storage costs involved in disposal.)

Ask: Why might companies not use a waste exchange? (Fear of liability for hazardous substances; takes too much time; costs too much.)

6. **Ask:** What do all these reasons have in common? (money) What is the best way to make a waste exchange work? How could governments encourage businesses to use waste exchanges? (Tax breaks for firms that use waste exchanges; protect businesses that use waste exchanges from lawsuits; promote research on the recycling and reuse of hazardous wastes; develop grants to help small business, etc.) Ask students if they can think of any other institutions or organizations that could benefit from a waste exchange. (Schools, colleges, government labs, military bases, etc.)

Ask: Does our school generate hazardous wastes? (chemistry labs, industrial arts shops, arts and crafts classes, auto shop, biology labs, etc.)

7. **Ask:** What is our school doing to reduce or recycle hazardous wastes? How can we find out? Form groups of three to five students and assign each group one of the following areas to investigate. Arrange to have someone available in each of these areas for students to question regarding hazardous waste generation and management:

- chemistry labs
- biology labs
- industrial arts shop
- arts and crafts classes
- cafeteria, food service and home economics departments
- printing and duplicating center
- cleaning and maintenance shop

Have each group prepare a brief report to the class on what it finds. This report should include information on the following:

a. What kinds of hazardous wastes are generated? Use the categories that are found on the handout "Industrial and Commercial Hazardous Wastes Categories"
b. At present is there any way to recycle these hazardous wastes?
c. What does it cost to dispose of the wastes now?
d. What are the regulations that apply to specific hazardous substances used or created?
e. How hard would it be to develop a way to recycle these wastes? Could any of the hazardous wastes from one school area be used by another?

8. When all the reports have been presented, discuss with students the problems and difficulties they encountered in finding out about the hazardous substances in their school.

Ask: How could we as individuals help promote environmentally sound and economical hazardous waste management strategies? (Become informed about products that generate a lot of hazardous substances in their manufacture; find substitutes for these products and don't buy new ones; write to your legislative representative about establishing a government supported waste exchange, etc.).

Adapted from ***A-WAY WITH WASTE, 1990***

SOME INDUSTRIAL & COMMERICAL HAZARDOUS WASTE CATEGORIES

Worksheet

Waste Category	Hazard Characteristic(s)	Other Considerations
Acids/Bases		
Cyanide Wastes		
Filtration Residues		
Formaldehyde		
Heavy Metals and Inorganics		
Ink Sludges		
Oils (used)		
Pesticides		
Preserving Agents		
Solvents/ Degreasers		
Spent Plating Wastes		

Source: ***A-WAY WITH WASTE, 1990.***

SOME INDUSTRIAL & COMMERICAL HAZARDOUS WASTE CATEGORIES

Answer Key

Waste Category	Hazard Characteristic(s)	Other Considerations
Acids/Bases	Corrosive, Reactive	Can sometimes react violently with water
Cyanide Wastes	Toxic	
Filtration Residues	Corrosive, Reactive, Toxic	
Formaldehyde	Toxic	Sensitive populations (1)
Heavy Metals and Inorganics	Toxic	Persistent; sensitive populations (2)
Ink Sludges	Toxic	Persistent; sensitive populations (2)
Oils (used)	Toxic	Persistent; sensitive populations
Pesticides	Toxic	Persistent (3)
Preserving Agents	Toxic, Corrosive	
Solvents/ Degreasers	Corrosive, Reactive, Ignitable, Toxic	Sensitive populations (1)
Spent Plating Wastes	Corrosive, Toxic	

1. Some individuals are especially sensitive.
2. Children are especially at risk to lead exposure.
3. Chlorinated pesticides can bioaccumulate.

Source: ***A-WAY WITH WASTE, 1990.***

BUSINESSES GENERATING HAZARDOUS WASTES

Type of Business	Hazardous Wastes Generated
Auto Repair and Maintenance	Lead-Acid Batteries Heavy Metals Solvents Acids/Bases Used Oils
Building Cleaning and Maintenance	Acids/Bases Solvents
Cleaning Agents and Cosmetics	Acids/Bases Heavy Metals/Inorganics Solvents
Electric and Computer Chip Manufacturers	Acids/Bases Spent Plating Wastes
Farmers and Agricultural Service Shops	Pesticides Solvents Used Oils
Furniture/Wood Manufacturing/ Refinishing	Solvents
Laundries and Dry Cleaners	Dry Cleaning Filtration Residues Solvents
Motor Freight Terminals and Rail Transport	Acids/Bases Lead-Acid Batteries Heavy Metals/Inorganics Solvents Used Oils
Printing Industries	Acids/Bases Heavy Metals/Inorganics Ink Sludges Spent Plating Wastes
Schools, Labs and Vocational Shops	Acids/Bases Solvents Heavy Metals/Inorganics
Wood Working (Boat builders, lumber mills, etc.)	Preserving Agents

Source: ***A-WAY WITH WASTE, 1990.***

RISKS AND BENEFITS

Goals:
Students will:
- list some of the hazardous materials that are transported or stored in their community.
- discuss and list the risks and benefits associated with the transportation and storage of various hazardous materials within their community.
- describe the routes by which spilled hazardous materials in their community may contaminate the groundwater supplies.
- describe some of the health risks associated with potential spills of hazardous materials within their community.

School Subject:
Science, Social Studies

Grades:
9th - 12th

Time:
1 class period

Materials:
- Student worksheets

BACKGROUND

Hazardous materials which are transported or stored in your community all have various associated risks and benefits. The benefits are usually the same - stockpiling near area of use, bulk handling to save energy and cost, on-hand inventory at point of manufacture or production, etc. The risk of spill depends upon the method and timing of transportation and storage. The health risk depends upon the local drainage patterns, geology, water supply practices, etc. Help the students see that all of these hazardous substances carry attendant risks and benefits. If there were no benefits, we would not be transporting or storing them. Working first in small groups and then discussing as a whole class should enable the students to come up with suitable answers for the worksheet.

PROCEDURE

1. Divide the class into groups of four to six students.

2. Hand each of the students a worksheet. Instruct them to discuss the items within their group, as they fill out the worksheet. Tell them that they will be sharing their findings with the whole class in a concluding discussion.

3. Allow adequate time for the small groups to complete their discussion (perhaps twenty minutes).

4. Circulate from group to group during the work time to listen, offer suggestions, or give encouragement.

5. After the small group work is completed, lead a class discussion allowing the small groups to share what they have written with everyone. Ideas may be put on a blackboard or flipchart for everyone to see. Groups should be encouraged to compare and even debate ideas.

Adapted from **GREAT, 1989**

Risks and Benefits Student Worksheet

Name:____

DIRECTIONS:

For each example tell at least 2 risks and 2 benefits. Also, describe how a spill of the material might contaminate the groundwater and explain what possible health risks the material may present for us.

EXAMPLE

Transportation of low level nuclear waste across California on trucks travelling Interstate Highway 80 from Nevada to San Francisco.

Risks:

A traffic accident may spill radioactive waste. Wastes may spill during loading or unloading.

Benefits:

Radioactive materials are useful in treating cancer and other medical procedures. The state needs an economical way to transport nuclear wastes.

Possible groundwater contamination:

Soil may become contaminated in the event of a spill. Water seeping down to the water table may carry radioactive material down.

Possible health risks:

A spill of radioactive material may expose people to radiation causing illness or even death. If the water supply is contaminated it may not be drinkable for a long time.

Risks and Benefits Student Worksheet

Name:____________________________________

DIRECTIONS:

For each example tell at least 2 risks and 2 benefits. Also, describe how a spill of the material might contaminate the groundwater and explain what possible health risks the material may present for us.

EXAMPLE ONE

Storage of gasoline in large underground tanks at the local service station.

Risks:

Benefits:

Possible groundwater contamination:

Possible health risks:

Risks and Benefits Student Worksheet

Name:____________________________________

DIRECTIONS:

For each example tell at least 2 risks and 2 benefits. Also, describe how a spill of the material might contaminate the groundwater and explain what possible health risks the material may present for us.

EXAMPLE TWO

Storage of liquid nitrogen fertilizer in large above ground tanks at the local farm service store at the edge of town.

Risks:

Benefits:

Possible groundwater contamination:

Possible health risks:

Risks and Benefits Student Worksheet

Name:____

DIRECTIONS:

For each example tell at least 2 risks and 2 benefits. Also, describe how a spill of the material might contaminate the groundwater and explain what possible health risks the material may present for us.

EXAMPLE THREE

Storage of large inventory of insecticides, herbicides, and other pesticides at a large nursery near the center of town.

Risks:

Benefits:

Possible groundwater contamination:

Possible health risks:

Risks and Benefits Student Worksheet

Name:____________________________________

DIRECTIONS:

For each example tell at least 2 risks and 2 benefits. Also, describe how a spill of the material might contaminate the groundwater and explain what possible health risks the material may present for us.

EXAMPLE FOUR

Transportation of natural gas through our community via a pipeline.

Risks:

Benefits:

Possible groundwater contamination:

Possible health risks:

SITE UNSEEN?

BACKGROUND

It is now widely know as the NIMBY syndrome: "Not In My Backyard". This is the prevailing response of a wary public expressing their concern and frustration over hazardous waste disposal practices and many other issues. As existing sites fill up and Resource and Conservation and Recovery Act (RCRA) regulations force the closing of others, the location of new facility sites has become a critical issue.

PROCEDURE

1. Make sure the container being used as the "hot potato" is clean and unbreakable. Put the container on a student desk. Hold up the "hazardous waste hot potato".

Say: Because of its dangerous qualities, we can no longer keep this hazardous waste "hot potato" in this classroom.

Ask: Do you think any other classroom would be willing to store it? What will they ask us if we try to give it to them?

2. **Say:** All other classrooms have been told the same thing. The law now requires us to remove all "hazardous waste hot potatoes" from the school. The law also says that if we allow dangerous substances to be used in our city or county then we must also find a place in our city and county where the "hot potatoes" can be either made less dangerous or completely harmless or safely stored until they can be taken to a hazardous waste landfill or incinerator.

Goals:
Students will:
- develop criteria for siting a hazardous waste facility and use these criteria to evaluate sites in their area.
- understand the problems involved in making decisions about managing hazardous wastes.

School Subject:
Social Studies, Science, Geography.

Grades:
7th - 12th

Time:
1- 2 class periods.

Materials:
- A container of household product that if improperly stored or disposed of might threaten public health and the environment, e.g., nail polish, batteries. This container is the "Hazardous Waste Hot Potato"
- A topographic map of local area or county
- Red dot stickers

3. **Ask:** What do we need to consider in selecting a safe place to put our "hazardous waste hot potatoes"? Do we need to make sure that the "hot potato" doesn't get into the water? Into the air? Or on the land where we grow food?

4. Have students develop a list of site location criteria. Compile the lists on the board. Help develop the following criteria:

- Should not be too near a stream or river or any source of drinking water.

- Should be constructed to prevent leakages of dangerous substances in the air, land or water.
- Should be near the places where dangerous substances are manufactured or used.
- Should not be too near peoples' homes, etc.

Review the class' criteria for selecting a hazardous waste treatment and storage site. For each criterion ask why.

Discuss: Do some criteria conflict?

5. Display the city/county map. Divide the class into groups of three or four.

Ask: Where are some locations that we might put our "hot potatoes"?

6. Give each group a sticker, and 10 minutes to decide where to put their "hot potato" and other dangerous waste that may be produced in their town. At the end of 10 minutes, have one student from each group identify the site they picked by putting its sticker on the map.

7. **Ask:** How are we going to decide which of these places is best for the community and for all the different "hot potatoes" that we have in our community?

Ask: Who should be involved in making the final decision? (The people who produce "hot potatoes" or the people who use them, or both, etc.)

8. Go over each location selected by the groups. Ask each group to explain why they selected their particular site.

Ask: Which of the criteria is the most important? How did you decide? Was it hard to agree?

9. Have the entire class vote to pick a final site. Tally the results on the board.

Ask: Did the proximity of the site to your home have anything to do with how you voted?

Adapted from ***A-WAY WITH WASTE, 1990, and LIVING LIGHTLY ON THE PLANET, 1987***

NIMBY

OVERVIEW

Students simulate a meeting of the County Board of Supervisors to resolve a hazardous waste disposal problem.

Goals:
Students will:
- understand what is involved in the generation of hazardous waste.
- become aware of the problems involved with disposal of hazardous waste

School Subject:
Social Studies, Government.

Grades:
10th - 12th

Time:
2- 3 class periods

Materials:
- Handouts and Role Cards

BACKGROUND

Land Disposal of Hazardous Waste

The Environmental Protection Agency (EPA) and the California Department of Health Services publish regulations which restrict the disposal of hazardous waste. Each year, approximately 33 billion gallons of hazardous waste are disposed of in landfills, surface impoundments (similar to swimming pools), land treatment units, and waste piles, without prior treatment. Another 37 billion gallons of hazardous waste are injected into deep wells. Almost 900 leaking hazardous waste sites have been identified around the country and thousands more may be threatening underground water supplies. Many abandoned or closed dump sites are not monitored for potential health and environmental hazards.

Land disposal of hazardous waste is presently restricted to areas which have specific characteristics. These include locations which are an adequate distance above the water table, away from surface water, and have specific soil conditions (i.e., impermeable clay layers).

Alternative Methods to Land Disposal

Technology for alternative disposal of many hazardous substances does exist. The costs, however, are much higher than the cost of land dumping. Using physical, chemical, thermal, and biological processes, scientists and engineers often can extract and recycle useful materials from hazardous waste. Some remaining waste can be detoxified or neutralized through a chemical process before storing and/or disposing. Some wastes can be burned in special high temperature incinerators equipped with proper pollution control and monitoring systems.Regulatory agencies require that most toxic wastes be destroyed, deytoxified, or immobilized through some type of treatment. The Resource Conservation and Recovery Act stresses waste minimization, recycling, and reuse as the preferred solutions to the hazardous waste problem.

DISCUSSION FACTS

1. **Fact**: Our lifestyles are more convenient due to chemicals. There are over 65,000 chemicals in general use today, with about 1,000 more being generated each year.

2. **Ask:** What kind of businesses and industries generate hazardous wastes? (chemical manufacturers, auto repair shops, printing shops, paper industry, construction, agriculture, computer industries, schools, mines, etc.)

What does hazardous mean? (harm to human health or the environment; something that is corrosive, ignitable, toxic, or reactive; etc.)

Once a hazardous waste is generated, what do we do with it? (dispose of it in various ways)

3. **Fact**: The majority of both onsite and offsite disposal of hazardous wastes is deposited untreated. However, California's regulatory program is designed to phase out land disposal of untreated hazardous wastes. In the fiscal year 1987-1988, over 3 million tons of hazardous waste was disposed of in landfills, surface impoundments, land treatmentunits, injection wells, and waste piles without prior treatment.

In California, there are over 300 sites on the State Superfund list to be cleaned up, due to hazardous waste activity. The 300 does not include all of the sites that exist. Over 5000 sites are on a waiting list; these are sites that have some indication of hazardous waste activity. Land disposal is currently restricted to areas which have specific characteristics. These include locations which are an adequate distance from surface water, above the water table, and have specific soil conditions.

4. **Ask:** What are some alternatives to landfills? (source reduction; extraction and recycling of useful materials from hazardous waste; incineration; solidifying and /or stabilizing; treatment of remaining wastes to reduce volume and toxicity)

PROCEDURE

This simulation is designed to involve students in a decision making process concerning the placement of a hazardous waste landfill. It will help them recognize the complexity of individual and community rights regarding hazardous waste disposal.

NOTE: Students could attend a local board or council meeting to become familiar with the procedures of such a meeting.

Use the attached handouts and current newspaper or magazine articles to stimulate discussion.

1. Explain that the students will participate in a simulation of a Board of Supervisors meeting, which will be held to resolve a conflict, involving fictitious Brevard County.
2. Distribute the handouts "Problem Sheet" and "Brevard County Map". Students will use these to prepare for discussion.
3. Distribute the role cards and split the class into seven groups:
    (1) Brevard County Board of Supervisors (five members)
    (2) President and Vice President of ECO-CHEM Control Corp.
    (3) President and Vice President of the Anders Landfill and Dump Co.
    (4) Citizens of the Brentwood neighborhood
    (5) Citizens of the Longworth neighborhood
    (6) Business people of the Millerton Shopping Mall
    (7) County planners
4. Appoint a board chairperson who will be able to preside over the meeting.
5. Participants read their cards, discuss in groups their options, and come up with their statements.
6. Convene the Board of Supervisors meeting. The chairperson should restate the alternatives listed on the problem sheet.
7. Each group has 3 minutes for presenting their viewpoint.

8. After all statements have been heard, allow time for questions and rebuttals.

9. Have the Board of Supervisors recess for five minutes to make its decision.

10. Reconvene the meeting and have the chairperson announce the decision of the Board.

11. Conclude with a class discussion on the outcome.

SUMMARY

Discuss with students:

1. What difficulties did you encounter in preparing defenses for each of the positions?

2. What factors did the Board of Supervisors consider when making its decision? What other factors do class members think the board should have considered? What factors should be considered in determining the welfare of the county as a whole?

   a. What effect did the special interest groups and their statements have on the board?

   b. Are there county residents whose needs were not represented? Were their interests identified and considered in any way? What makes the opinions of a county resident important?

   c. Should the personal interests of the board members be considered in the decision? Why or why not?

   d. Were there any compromises made to enable the board to make its decision? If so, what compromises? Did the compromise(s) deal directly with the landfill and its location? Were compensations provided for citizens living near the landfill? If so, why? If not, why not?

3. Did anyone or any group look beyond their own special interests and consider the welfare of the county as a whole?

4. Did anyone's point of view change as a result of the hearing? Why?

Adapted from ***CLASS PROJECT, 1984.***

STUDENT HANDOUT

HAZARDOUS WASTE NEWS CLIPPINGS

NASA STUDIES WASTE DISPOSAL IN OUTER SPACE

NASA has awarded a $296,000 contract aimed at learning if potentially dangerous nuclear waste can be fired into orbit around the sun, into another solar system, or elsewhere in the universe. The company receiving the contract is to evaluate how best to launch nuclear trash, where in space to put it, how to bring the payload back if there is an aborted lift off. The program is a joint effort by the National Aeronautics and Space Administration and the Department of Energy.

PROCESSED WASTE "SAFE ENOUGH TO EAT"

In Hooksett, New Hampshire, the proposed $10 million hazardous waste processing plant will convert acids, alkalis, and heavy metal sludge into a rock-like substance that can be used as a base for highway construction or as an erosion control material. "It will yield by-products safe enough to eat," says the president of the firm that wants to build the processing plant.

COMPANIES DETOXIFY WASTE

Companies worried about leaking chemical drums or landfills like the Love Canal are trying to remove poisons from their waste by chemically converting compounds back into their harmless components. A researcher working to develop detoxification methods says, "If you have to store toxic waste, you're just postponing a solution." An officer in another research company says, "Almost total reliance has been placed on landfills. But burial is just long-term storage. While their hazardous waste can be limited, these processes are expected to increase in popularity because trucking of chemicals to special dumps is becoming more and more expensive."

JUSTICE DEPARTMENT SUES WASTE PRODUCERS

The Justice Department has asked the U.S. District Court in Baton Rouge, Louisiana to keep twelve oil and chemical companies from disposing any waste, hazardous or otherwise, at two sites near Baton Rouge where carcinogens and poisons are leaking into the environment. One of the sites is a large vertical hole drilled into a bluff. It was closed several years ago after it had been filled with waste, and covered with plastic and a layer of earth. Since then, the plastic has disintegrated and the earth has washed away. The Justice Department has asked the court to order the defendants to repair the plastic sheeting and install fences around the areas after doing tests and sampling.

TITAN SILOS FOR SOLID WASTE?

The southern Idaho desert is the final resting place for thousands of tons of toxic chemicals. The 80-acre facility, which formerly housed Titan One nuclear missiles, offers the extreme in safe disposal: "encapsulation" in underground silos designed to withstand forces as severe as earthquakes and bombing attacks. The Air Force abandoned the sites in 1965 when the Titan became obsolete, and a disposal company later bought it. The president of the company says, "We are 3,300 feet above the water table, and there is nothing but impermeable clay between the site and the water table. It is locked up forever and cannot get out." A senior specialist with the Idaho Department of Health and Welfare says the company has a pretty clean operation that meets all state standards. The company expects to buy other similar sites for disposal of more waste materials.

STUDENT HANDOUT

HAZARDOUS WASTE NEWS CLIPPINGS (Cont'd)

THOUSANDS OF WASTE SITES TO BE CLEANED UP

"The Office of Technology Assessment, a research arm of Congress, contends that there may be at least 10,000 hazardous waste sites in the U.S. that pose a serious threat to public health and that should be given priority in any national cleanup. The cost, OTA estimates, could easily reach $100 billion, or more than $1,000 per household."

SEEPING POISONS

"Toxic dumps where steel drums have been left to rust and leak, letting poisons seep into the earth for decades, are scattered in virtually every county of every state. They present a potentially irreversible threat to water supplies, public health, and the economy."

LANDFILLS - TEMPORARY SOLUTIONS

"But most experts consider any landfill only a temporary solution to the chemical-waste problem. Eventually, all will develop cracks or gradually give way to the corrosive action of the potent chemicals."

CURBINGS AND BURNING WASTES

"A number of companies have made some headway in curbing a generation of the poisons... (one company) for example, cut its volume of toxic wastes in half... it also burns nearly all of the remaining wastes in a huge incinerator..."

A MODERN DISPOSAL FACILITY

"A prime example of a modern disposal facility is the one operated in Chicago. A giant excavation 35 ft. deep covers two acres. A floor of compacted clay approximately 40 ft. thick has been laid on the bottom of the hole. On top of this virtually impermeable bed, workmen are placing a plastic liner to be topped by a plastic-grid system that will collect and direct any seepage into a series of sump pumps. Above the grid will be another plastic liner, another layer of clay, and yet more plastic. A plumbing system will pump rainwater out of the area."

Source: Ed Magnuson, ***A PROBLEM THAT CANNOT BE BURIED***, © 1985 Time, Inc. All rights reserved. Reprinted by permission of TIME.

STUDENT HANDOUT

PROBLEM SHEET

Brevard County has a problem. Chemicals from a leaking landfill must be moved to a secure landfill. In a neighborhood near Brevard County, all families now receive their water from a truck because their wells have been contaminated by toxic chemicals from a city-owned landfill. If Brevard County residents wait too long, this could happen in their neighborhood too.

In Brevard County, the Board of Supervisors is considering building a special clay-lined landfill for the chemicals which must be moved from the present disposal site. The clay lining will keep hazardous chemicals from seeping into the groundwater. Special wells, from which water will be drawn and monitored for contamination, will be built around the landfill. If chemicals are leaching from the landfill, they will show up in the wells surrounding it. The water could then be detoxified before it would affect the drinking water supply. When the landfill is full, it will be capped with clay to seal it.

The money required to build the landfill and operate it safely will come from county taxes. It will cost $2.3 million to build the landfill. Sending the drums to an operating EPA-approved site 800 miles (1287 kilometers) away would cost $1.4 million. Any additional funds for construction of the new landfill would be raised through a bond referendum. If this special landfill is built, Brevard County will be able to accept other chemicals for storage, giving the county an annual income of $100,000 to $200,000. Three possible sites in Brevard County have been proposed for the disposal:

- 30-acre (12.1 hectare) plot in the Brentwood neighborhood;
- 30-acre plot in the Longworth neighborhood;
- 30-acre plot near the Millerton Shopping Mall.

These sites have been specially selected because the nearest stream to all three sites is at least 500 feet (152.4 meters) away, and the water table is at least 50 feet (15.2 meters) below each proposed landfill site. Even though the county will follow EPA regulations in building and monitoring the landfill, the citizens in these areas do not want it near them.

The Board of Supervisors must decide how to solve the problem. Board members are elected, and three of them represent and live in the neighborhoods which are being considered as sites. A hearing is being held to discuss the problem. The citizens of the three proposed landfill sites have asked for time at the hearing to state their objections.

STUDENT HANDOUT
HAZARDOUS SUBSTANCES SIMULATION ROLE CARDS

Board of Supervisors

The decision rests with you: Where should the chemical landfill be located? It is up to you to recognize your own special interests and the interests of each group making statements before the board. The decision you make must go beyond the special interests of any one group and consider the best interests of the *county as a whole.*

Decide which three board members live in and represent each of the three areas where the landfill could be located. Then, consider these questions:

1. What are the advantages and disadvantages of each location for the landfill? What, if any, other options could you consider?
2. How will you take into consideration the feelings of the local citizens in making your decision?
3. What criteria are you going to use to analyze the statements made by the citizens? Make a list of these.
4. What factors besides the local citizen reaction will you be considering as you work toward a decision?
5. Is there room for compromise in reaching a decision? If so, do you think citizens will be willing to make compromises? In what way? What compromises can you offer them?

You can ask questions of each group after it has presented its point of view. When all groups have completed their presentations, consider all alternatives open to you for the disposal of hazardous waste. You may consider other solutions as well. The solution the board chooses must be acceptable to the majority of the board members.

ECO-CHEM Control Corporation

You manage an EPA-licensed landfill corporation for hazardous waste disposal. You have a licensed chemical landfill located 800 miles (1287) kilometers) from Brevard County. The bottom of your landfill contains several feet of clay and has a 2 layer plastic liner on top of it to further assure a non-leaking site. The clean-up would be very expensive. The county would have to spend $1.4 million to send the waste from their dump to your landfill, but they would not have to build their own.

You must convince the board that it is better to send the hazardous waste to your landfill. You may include any information you have learned in previous lessons or from news articles. In your statement, answer these questions:

1. Why is it safe to build this landfill?
2. How do you mange your landfill?
3. What advantages would there be for the county if it sent its chemicals to you?

Anders Landfill and Dump Company

You will get the contract to develop the landfill it is built in Brevard County. You need the $2,3 million contract. Your business has been in a slump lately.

You must convince the Board of Supervisors to build the landfill in Brevard County. Prepare a statement for the board. You may use any information you have learned in previous lessons or from news articles.

1. Why is it safe to build this landfill?
2. What are the advantages of having the landfill located in the county?
3. Why should you be given the contract?

STUDENT HANDOUT
HAZARDOUS SUBSTANCES SIMULATION ROLE CARDS (Con't)

County Planners

You think the landfill should be located in the county because the county will receive between $100,000 and $200,000 annually from companies bringing their chemical waste to the landfill. This money can be used to increase services to the county. Parks and a new swimming pool can be built, and county roads can be improved. You must prepare a statement for the Board of Supervisors which will persuade them to locate the landfill in the county. Your statement should point out the benefits the county will be able to finance with the profits from the landfill.

You do not know where within the county the landfill should be built. However, you do not want it built in the area where you live.

Citizens of the Brentwood Neighborhood

You do not want the landfill in your area! You are afraid the chemicals will evaporate into the air or seep into the groundwater. Your water supply comes from the wells which you are afraid will be contaminated. Your neighborhood begins 300 yards (274.3 meters) from one of the proposed sites for the waste landfill. There are many young children in your neighborhood and they play only 100 yards (91.4 meters) from this site.

You must prepare a statement for the Board of Supervisors to persuade them to locate the landfill elsewhere. News articles and the discussion your class had about alternate methods of disposal may help you. Try to answer these questions in your statement:

You must prepare a statement for the Board of Supervisors to persuade them to locate the landfill elsewhere. News articles and the discussion your class had about alternate methods of disposal may help you. Try to answer these questions in your statement:

1. What health hazards could the landfill pose to you and your family?
2. Your taxes are being used to pay for the landfill. Is the landfill the best use of your taxes?
3. Where should the landfill be constructed?
4. What other disposal methods do you recommend?
5. Is there something the county supervisor could do which would minimize your objections to having the landfill close to your area? If there is, propose it to the Board during the hearing (if you are willing to make compromises in your position).

STUDENT HANDOUT
HAZARDOUS SUBSTANCES SIMULATION ROLE CARDS (Con't)

Citizens of the Longworth Neighborhood

You do not want the landfill in your area! You are afraid the chemicals will get into the air and water and cause health problems. Your neighborhood is only 300 yards (274.3 meters) from one of the proposed landfill sites.

Your taxes are being used to build the landfill. As taxpayers, you think you should have the right to stop the landfill.

You must prepare a statement for the Board of Supervisors to persuade them to locate the landfill somewhere else. News articles and the discussion your class had about alternate methods of disposal may help you. Try to answer these questions in your statement:

1. What health hazards could the landfill pose to you and your family?
2. Your taxes are being used to pay for the landfill. Is the landfill the best use of your taxes?
3. Where should the landfill be constructed?
4. What other disposal methods do you recommend?
5. Is there something the county supervisor could do which would minimize your objections to having the landfill close to your area? If there is, propose it to the Board during the hearing (if you are willing to make compromises in your position)

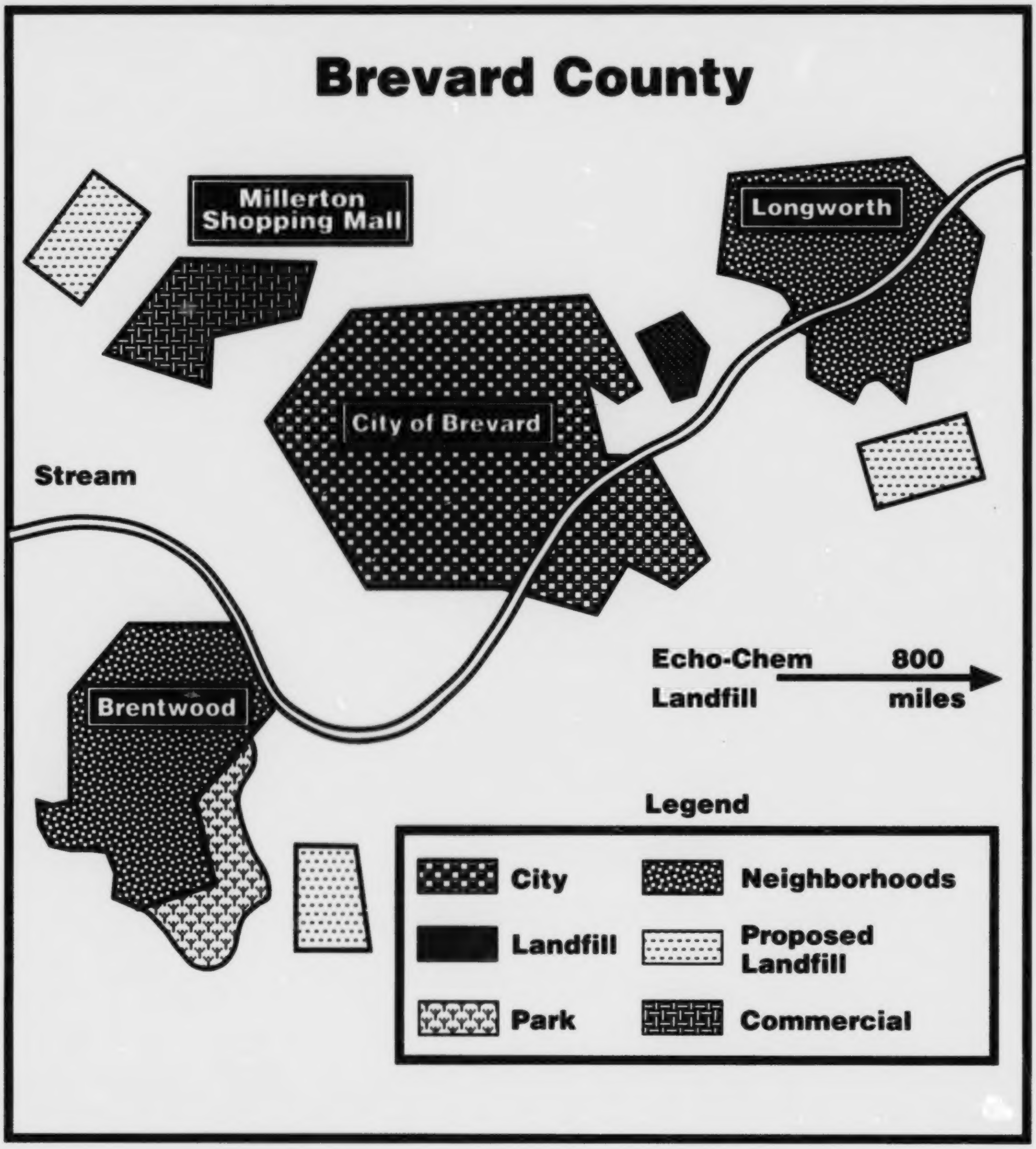
Business People of the Millerton Mall

You do not want the landfill in your area! You are afraid it will contaminate the water supply for the mall and hurt your business. People might not shop at a mall near a chemical landfill, and you might have trouble keeping employees if they are afraid to work near a hazardous waste landfill. You are also afraid that the chemicals could cause health problems for you, since you spend six days a week at the mall. The landfill would be located at a site 300 yards (274.3 meters) from the mall.

You must prepare a statement for the Board of Supervisors to persuade them to locate the landfill somewhere else. News articles and the discussion your class had about alternate methods of disposal may help you. Try to answer these questions in your statement:

1. What health hazards could the landfill pose to you and your family?
2. Your taxes are being used to pay for the landfill. Is the landfill the best use of your taxes?
3. Where should the landfill be constructed?
4. What other disposal methods do you recommend?
5. Is there something the county supervisor could do which would minimize your objections to having the landfill close to your area? If there is, propose it to the Board during the hearing (if you are willing to make compromises in your position)

Transparency A
BREVARD COUNTY MAP


Brevard County
Millerton Shopping Mall
Longworth
City of Brevard
Stream
Brentwood
Echo-Chem Landfill
800 miles
Legend
City
Neighborhoods
Landfill
Proposed Landfill
Park
Commercial

BEST COPY AVAILABLE

HOUSEHOLD HAZARDOUS SUBSTANCES

BACKGROUND INFORMATION

Homes are full of hazardous substances. Detergents, degreasers, household cleaners, automotive lubricants, paint strippers, stain removers, and do-it-yourself aids have made our homes miniature chemical factories.

Are all these substances necessary? Are there safer alternatives? If they must be used, how can this be done with safety? What are responsible disposal options for them?

These substances may be poisonous, flammable, corrosive, reactive or carcinogenic. They may contaminate the air, the soil, or water, and endanger the environment. Many are not readily biodegradable, and concentrate in food chains. Decontamination is difficult and expensive.

Use of these products can present a danger to health. They may be ingested, absorbed through the skin, or inhaled. Exposure may result in immediate illness, or symptoms may not appear until years later. They also pose a danger to the environment. With proper precautions, however, the risks associated with these products can be greatly reduced.

Adapted from ***THE HAZARDOUS WASTE KIT, 1985.***

WEE WILLIE CHEMICAL

Wee Willie Chemical
Runs through the drain,
A blessing that he cuts the grease
And keeps your mother sane.

And yet he runs right through the pipe
And all the way to the ocean,
Where mixed with other chemicals
He might cause much commotion!

Wee Willie Chemical
Needs us to decide
When he's needed in the drain and
When in the can he can hide.

So be careful how you turn him loose,
And when you throw him away,
For if Wee Willie's persistent,
He's in the water to stay!

While Wee Willie Chemical
May be happy in the ocean,
Of what he'll do to fish and fowl,
We haven't much a notion!

From: **SLEUTH, 1982**

WHAT GOES AROUND COMES AROUND

Goals:
Students will:
- understand the environmental consequences, particularly the effects on water, of a variety of household hazardous waste disposal methods.
- learn where persistent household hazardous wastes go when they are thrown out.

School Subject:
Science, Social Studies

Grades:
7th - 12th

Time:
3 - 4 class periods

Materials:
- Examples of commonly used household hazardous products, such as motor oil, pesticides, paint thinner, etc.
- Protective gloves
- Overheads: "Routes to the Environment" and "Bioaccumulation".
- Disposal Information Sheets
- "Where Will It End Up" chart

BACKGROUND

Hazardous substances can enter our environment in a wide variety of ways. Because the subject is so large, this activity is primarily informational in nature.

PROCEDURE

1. Bring to class one or two examples of some common types of household or school hazardous substances. Motor oil, pesticides and paint thinner are good examples of products that are known to be persistent and long lasting in the environment. Handle these products with care. You may wish to bring empty containers only. Restrict student handling of these products. Wearing gloves for protection will emphasize the hazardous nature of these products.

2. Explain that some combinations of hazardous chemicals degrade (break down) quickly into safe, naturally occurring substances. Explain that this activity is primarily concerned with persistent hazardous chemical combinations, i.e. those that remain unchanged in the environment for long periods, or with chemicals that combine with natural substances in such a way as to pose a hazard to humans and other living organisms. Show the overhead "Bioaccumulation" and discuss the concept with students.

3. Show the products that were brought to class. **Ask:** What should we do with these products when we are through with them? What are the different ways we might dispose of them? (Recycle, flush down the drain, put in the garbage can, burn in the backyard, pour out on the ground or pavement.) Tell students that some disposal options are no longer legally available. However, for the purposes of this activity the students should think about what happens to substances when they are disposed of in various ways. Discuss with students any disposal directions that are written on the product. For example, most motor oil containers suggest recycling.

4. Discuss with students that the study of ecology involves the examination and understanding of connections. Tell students that the class will now consider how each of the possible ways people

might dispose of household hazardous waste could be connected to food and water supplies.

5. Tell students they are now going to consider where wastes go. Show the overheads "Routes to the Environment I and II". Point out to the class the various ways a chemical can travel through the environment from our homes.

6. Divide the students into groups or pairs and assign a different disposal method to each group.

- incineration
- storm drain, ditch, hole in the ground
- sink/toilet
- garbage can
- household hazardous waste collection

Have each group brainstorm for several minutes about where substances disposed of by their disposal method might end up. A different hazardous product can be assigned to each group. Pass out the appropriate disposal option sheet to each group. Questions that each group can ask themselves are:

- If we dispose of the product by this method what might happen?
- Is there any way that wildlife might be harmed?
- Is there any way this product could get into our drinking water?
- Is there any way this product could get into our food?

Tell the groups to use the "Where Will It End Up?" chart to record their ideas.

7. Have the groups share their ideas with the rest of the class. After each group presents their ideas, discuss with the class the information contained in disposal option sheets that are included with this activity. A different disposal option can be done each day, if preferred. Ask the class to vote on the best disposal choice for each product.

8. After all the options have been discussed, review with the class where persistent household hazardous waste goes. **Ask:** What can we do to reduce the amount of household hazardous waste we produce, in other words, eliminate or reduce the waste before it becomes a problem for us and the environment?

Have students brainstorm ways to prevent persistent hazardous substances from harming the environment. Have them think of solutions they themselves might do, such as:

- Don't buy products containing hazardous materials.
- Learn to read product labels.
- Use safer substitutes.
- Use up what you do have or, if it is not a banned chemical, find someone who can use it.
- Take it to a hazardous household waste collection program or a recycling center that handles hazardous substances.

Tell students that they can get information about participating in a collection program by calling their local health department, the California Department of Health Services, Toxic Substances Control Program and/or the California Integrated Waste Management Board.

DISCUSSION/TEST QUESTIONS

Why are persistent hazardous substances of particular concern in waste management?

What is bioaccumulation?

Name four different hazardous waste disposal options and an example of a product that should be disposed of using each option.

How can we reduce the amount of household hazardous waste we produce?

Adapted from ***A-WAY WITH WASTE, 1990, and SLEUTH, 1982***

COMMON DISPOSAL METHOD INFORMATION SHEET

INCINERATION

If you burn your household hazardous substances, what happens? This depends on the type of chemical in the waste being burned. A pressurized aerosol can could explode and cause injury. Burning paints could leave a toxic residue of heavy metals. Burning rags soaked with cleaning fluid might simply vaporize the liquid into the air. This would disperse it and thus make its concentration very low. Burning plastic containers or certain solvents however could release potentially harmful fumes like hydrogen cyanide or chlorine-bearing compounds that are harmful if inhaled. Some of the chlorine-bearing compounds do not break down easily and last a long time. Over a period of time, these compounds can accumulate to levels that are harmful to the atmosphere.

In addition, the burning of hazardous household items by individuals is never complete. This means that small particles from paper or cloth are released into the air. These particles, which can carry hazardous substances, may settle and form a very thin layer called a microlayer on different surfaces, such as plant leaves. The hazardous substances in the layers can interfere with vital biological processes. Microlayers can also form on the surface of water. Because microlayers form at the place called an interface where two different states of matter meet, such as liquid and gas or solid and liquid, it is much more likely that hazardous substances will become concentrated in these microlayers.

Finally, human beings can breathe small particles into their lungs and thus introduce the absorption of hazardous materials into the bloodstream. (Our lungs interface with the atmosphere.)

COMMON DISPOSAL METHOD INFORMATION SHEET

STORM DRAIN, DITCH, HOLE IN THE GROUND

If you pour hazardous household substances into a storm drain, a ditch, or a hole in your backyard there is a good chance the substance will end up in a nearby stream, river or lake. Here is where the waste is likely to go.

First, the storm drain. The square metal grates at the sides or curbs of streets are called storm drains or catch basins. When it begins to rain, the first drops soak into the ground, but once the soil is saturated or if it is covered by cement, the rain runs into these storm drains. They drain anything soluble on your driveway, backyard, or street into the storm sewer system.

Once there, this runoff water enters pipes which carry it to larger pipes or "trunk lines" buried under the ground. These pipes empty the water into the nearest waterway: a creek, river or lake. So if you pour used motor oil down the storm drain in the street in front of your house it very well may end up on the feathers of ducks or the gills of fish in a nearby lake.

In some areas, the storm drains join sanitary sewer pipes and the runoff water goes to a sewage treatment plant. This is called a combined sewer system. In this case, the water containing your hazardous waste will be treated. Some sewage plants have only a single treatment stage which will not eliminate most hazardous substances. Other sewage plants have secondary treatment systems that eliminate many more hazardous substances. However, these are very expensive. What kind of systems do you have in your city?

Next, the ditch, or your backyard. In some areas there are no storm drains. Once the soil is saturated, rainwater runs overland to the nearest ditch or gully and downhill to the nearest waterway. If you disposed of a household pesticide in your backyard and it rained hard the next day, the rain would carry your waste overland along the ditches to a waterway or down into the groundwater.

"Groundwater", "water table", "aquifer", "artesian well", "springs" all are names which describe where water is and what water does underground. Water drains or soaks into the ground until it hits an impermeable (difficult to penetrate) layer. The water then collects in the spaces between sand, gravel or rock particles. Underground areas where groundwater collects are called aquifers. Some aquifers replenish lakes or streams. Others are enclosed by layers of rock and do not move. Wells are drilled into both kinds of aquifers, those that flow and those like pockets. Aquifers around the country are becoming contaminated at an alarming rate, threatening drinking water supplies.

Where does your drinking water come from?

COMMON DISPOSAL METHOD INFORMATION SHEET

SINK/TOILET

When you pour the substance down the sink or flush it down the toilet, where does it go? It goes either to the sewage system or into a septic system.

The sewage system is a network of underground pipes that collects liquid waste from each house, store, office, factory and building and brings it together into huge pipes called trunk lines. These trunk lines carry enormous volumes of waste.

Not all that long ago sewage used to be dumped directly into rivers, lakes, bays and oceans. What problems did this create?

Now most cities and towns have sewage treatment plants to clean up sewage before it is pumped into a local water source. The pipes for these plants are so big you could probably stand up in them.

At the sewage treatment plant the water is treated with chlorine to kill any disease-causing organisms in the raw sewage. Much of the solid materials and some of the heavy metals are also removed by allowing them to settle out of solution. Common heavy metals are lead, zinc, mercury, and cadmium. Exposure to heavy metals, in any other than small concentrations, can be harmful to human and environmental health.

Some of the hazardous substances in the sewage biodegrade, while others, including some of the heavy metals, settle out in a residue called sludge. This sludge is usually disposed of in a landfill but is sometimes applied as a fertilizer to farming and/or forest land.

Some hazardous chemicals can be absorbed by plants. These plants, in turn, are eaten by animals and the chemicals can accumulate and concentrate to dangerous levels. This process is called bioaccumulation. As a substance moves from one organism to another through being eaten or absorbed, the substance is said to move through the food chain. Each link in the chain may accumulate the hazardous substance at higher concentrations. Human beings are often at the top of a food chain, which means the food we eat has had a chance to bioaccumulate many times. The EPA has set standards for the level of hazardous substances in sludge that may be used on farm or garden soils producing food.

If you poured a hazardous item down the sink, which food chains could these hazards enter?

Today we are only starting to recognize and understand the environmental damage caused by hazardous household products. There is no doubt that treatment removes or makes less harmful some of the hazardous substances found in sewage. Some hazards, however, are not removed and are pumped out into bodies of water such as the San Francisco and Santa Monica Bays.

If your house is not connected to a sewer system, it is probably attached to a septic tank. Gallons of water and sewage a day go through these septic systems.

Bacteria break down much of the waste entering a septic system. However, if you pour or flush hazardous waste into a septic system, the waste can kill these helpful bacteria and will contaminate the septic system's drain field soil or the septic tank sludge. The sludge, removed every four or five years from the septic tank is disposed of either at a sewage treatment plant in a septic lagoon or in a sludge landfill (basically a hole in the ground). The septic system cannot last indefinitely if the sludge tank is not pumped out periodically. At best the bacterial action will stop allowing harmful substances into groundwater and at worst the drain field will get blocked and cause the system to back up.

The suspected cancer causing chemical trichlorethylene, a powerful solvent and degreaser, has leached from septic tank drain fields in several places in the country to contaminate local wells. This compound, used in the past as a cleaner for septic tanks, is the suspected source. (source, Metro Toxicant Program Report No. 1E, Water Quality Division, Seattle, 1982) Chlorinated compounds make good cleaning agents, but they are persistent, toxic and mobile. Bacteria that can break down non-chlorinated substances cannot biodegrade these compounds, which pass through such systems into the drain field and ultimately may end up in drinking water sources.

COMMON DISPOSAL METHOD INFORMATION SHEET

GARBAGE CAN

Once you have put your trash in the garbage can, until recently, you probably didn't think about it any more. The garbage truck came by every week and took it away. But lately garbage has been much in the news. Remember the garbage barge?

What happens to your garbage after it is picked up? Where does it go?

In some areas, the garbage truck takes your trash to a transfer station. At the transfer station, the garbage is sometimes separated and then taken to a landfill.

Trash in landfills used to be burned to reduce the volume. This produced a relatively non-toxic ash, but sent a lot of very nasty stuff into the air. Consequently, open burning was stopped and replaced with compacting and burying of waste. Now the waste at a landfill is heavily compacted. As a result, almost any container will break and its contents spill. Now the problem is leachate.

At the landfill rainwater and any liquids in the waste soak through the garbage. Soluble (dissolvable in water) hazardous materials may be washed down with them. This liquid mixture is called leachate. Leachate will go down through the soil until it reaches an impermeable layer (a layer it cannot go through), or it will flow downhill over the surface. Leachate can contaminate ground and surface waters.

So if you throw hazardous household items in the garbage can, the waste's persistent components may end up in the soil near your local landfill and if they get into the ground and surface water, who knows where they will end up.

DISPOSAL METHOD INFORMATION SHEET

HOUSEHOLD HAZARDOUS WASTE COLLECTION

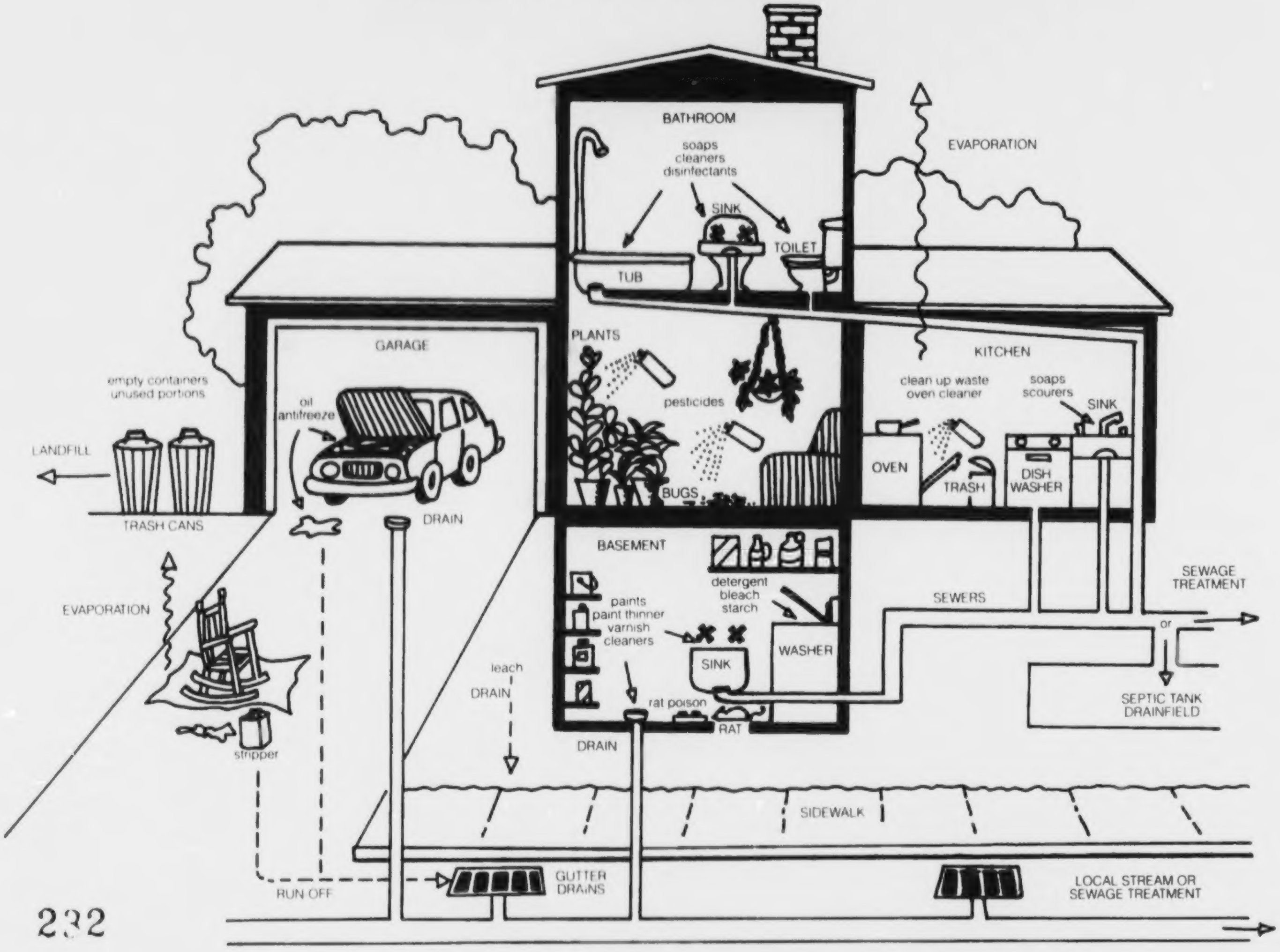
Several communities in California are now sponsoring household hazardous waste (HHW) collection programs. Many counties depend primarily on groundwater for drinking, and are concerned about safely collecting household hazardous wastes in order to keep them out of local landfills and out of drinking water.

During a household hazardous collection program, people can bring in, generally at no cost, household hazardous materials. In cooperation with private hazardous waste management companies, local, county and state workers record and pack hazards in drums for shipment.

Some of the material can eventually be rendered safe by hazardous waste management companies using various chemical, physical and/or biological techniques. Some can be recycled. Some must be shipped at a high cost, for disposal in a hazardous waste landfill or high temperature incinerator.

If you participate in a HHW program and take your household hazardous waste to a collection site, your waste will be safely handled. It will be transported for treatment, recycling, reclamation, long term storage or disposal.

ROUTES TO THE ENVIRONMENT I


BATHROOM
soaps
cleaners
disinfectants
SINK
TOILET
TUB
EVAPORATION
PLANTS
pesticides
BUGS
KITCHEN
clean up waste
oven cleaner
soaps
scourers
SINK
OVEN
TRASH
DISH WASHER
GARAGE
oil
antifreeze
DRAIN
empty containers
unused portions
LANDFILL
TRASH CANS
EVAPORATION
stripper
BASEMENT
paints
paint thinner
varnish
cleaners
detergent
bleach
starch
SINK
WASHER
rat poison
RAT
DRAIN
leach
DRAIN
SEWERS
SEWAGE TREATMENT
or
SEPTIC TANK DRAINFIELD
SIDEWALK
RUN OFF
GUTTER DRAINS
LOCAL STREAM OR SEWAGE TREATMENT

Adapted from **SLEUTH, 1982**

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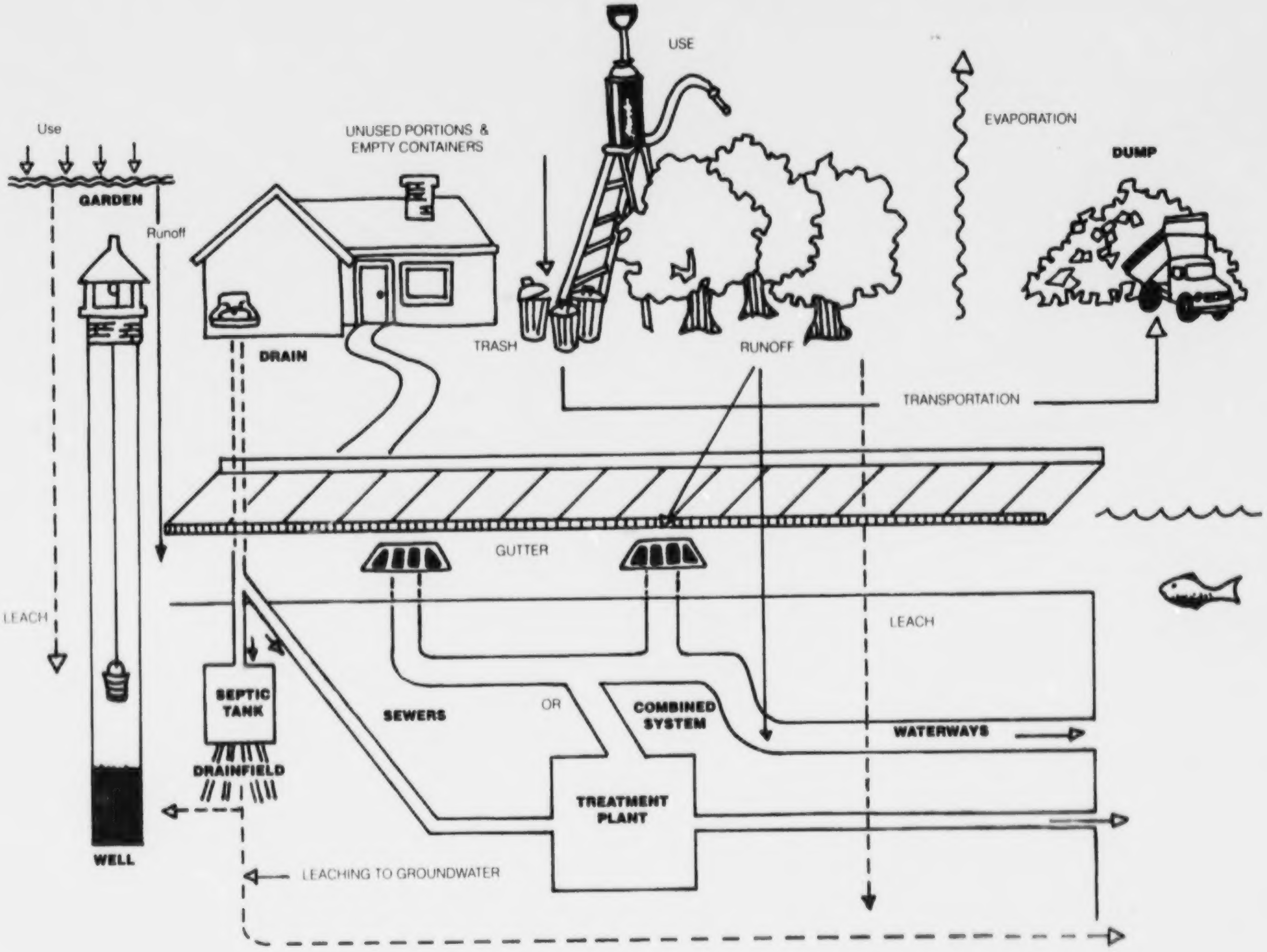
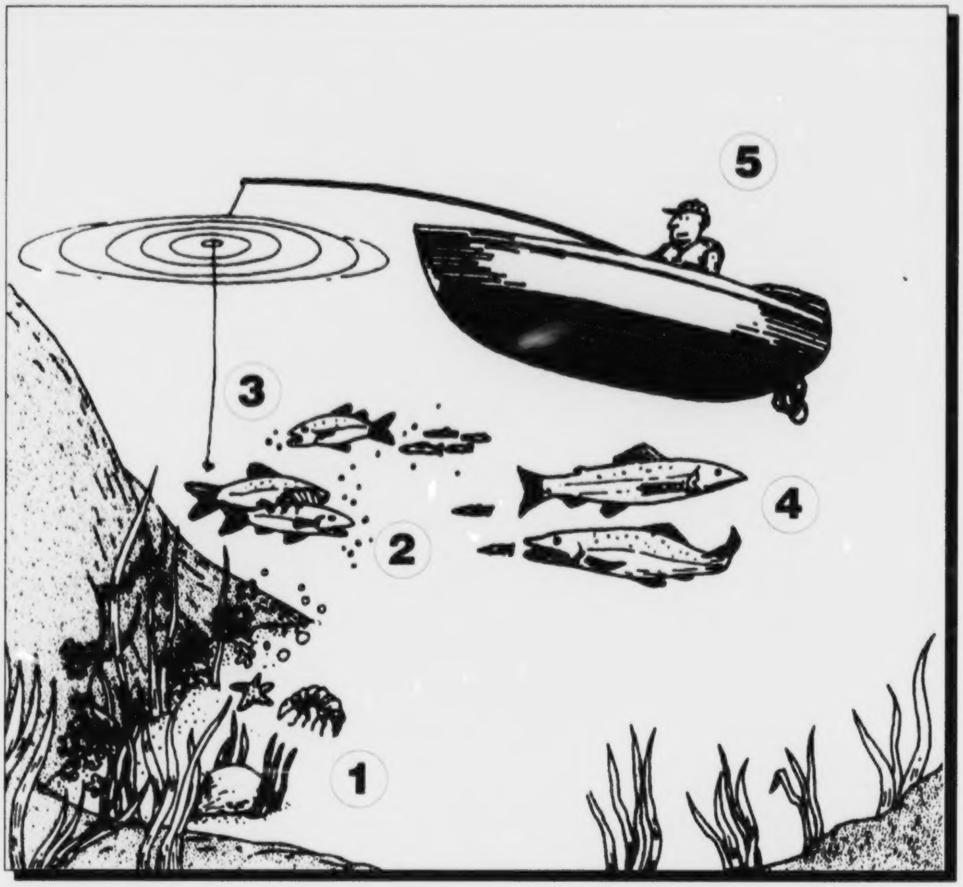
ROUTES TO THE ENVIRONMENT II


Use
GARDEN
Runoff
LEACH
WELL
UNUSED PORTIONS &
EMPTY CONTAINERS
DRAIN
USE
TRASH
RUNOFF
EVAPORATION
DUMP
TRANSPORTATION
GUTTER
LEACH
SEPTIC TANK
DRAINFIELD
SEWERS
OR
COMBINED SYSTEM
WATERWAYS
TREATMENT PLANT
LEACHING TO GROUNDWATER

Adapted from **SLEUTH, 1982**

Bioaccumulation



1. Some chemicals (PCB's will be used in this example) don't dissolve and don't break down easily. They stick to plants and particles in the water.

2. Small invertebrate animals such as aquatic insects and crustacians eat plants contaminated with PCB's or absorb PCB's from the water.

3. Small fish (alewives, chubs, perch) eat smaller animals.

4. Trout and salmon eat small invertebrates and smaller fish. Fish (both large and small) absorb PCB's directly from the water.

5. People catch and eat fish containing PCB's. Chemicals like PCB's that bioaccumulate collect in the fatty tissue and organs in humans.

Adapted from ***A-WAY WITH WASTE, 1990***

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Where Will It End Up?

Household Hazardous Waste
Disposal Choices

Incineration, Storm Drain/Ditch/Hole in Ground, Sink/Toilet, Garbage Can, Household Hazardous Waste Collection

Disposal Choice ____________________

Product	**Air**	**Water**	**Wildlife**	**Land**	**Other**
1. Paint Thinner					
2. Motor Oil					
3. Weed Killer					
4. Aerosols					
5.					
6.					

List as many possibilities as you can . If the disposal option can lead to pollution in the water— say what kinds of water (streams, groundwater, etc.)

Adapted from ***A-WAY WITH WASTE, 1990***

WORD PUZZLE

PROCEDURE

1. Tell the students that they are going to talk about some words and what they mean.

2. Read each "clue" to the children. After reading each clue, read the "words to use". Ask the students for the answers.

3. Assist children in getting the answer by giving them hints, or by reading only those words left after each "clue" is answered.

4. Answers:

   1. children
   2. dangerous
   3. poison
   4. warning
   5. keep out
   6. safe

Goals:
Students will be able to recognize and define common words relating to safety.

School Subjects:
Language Arts

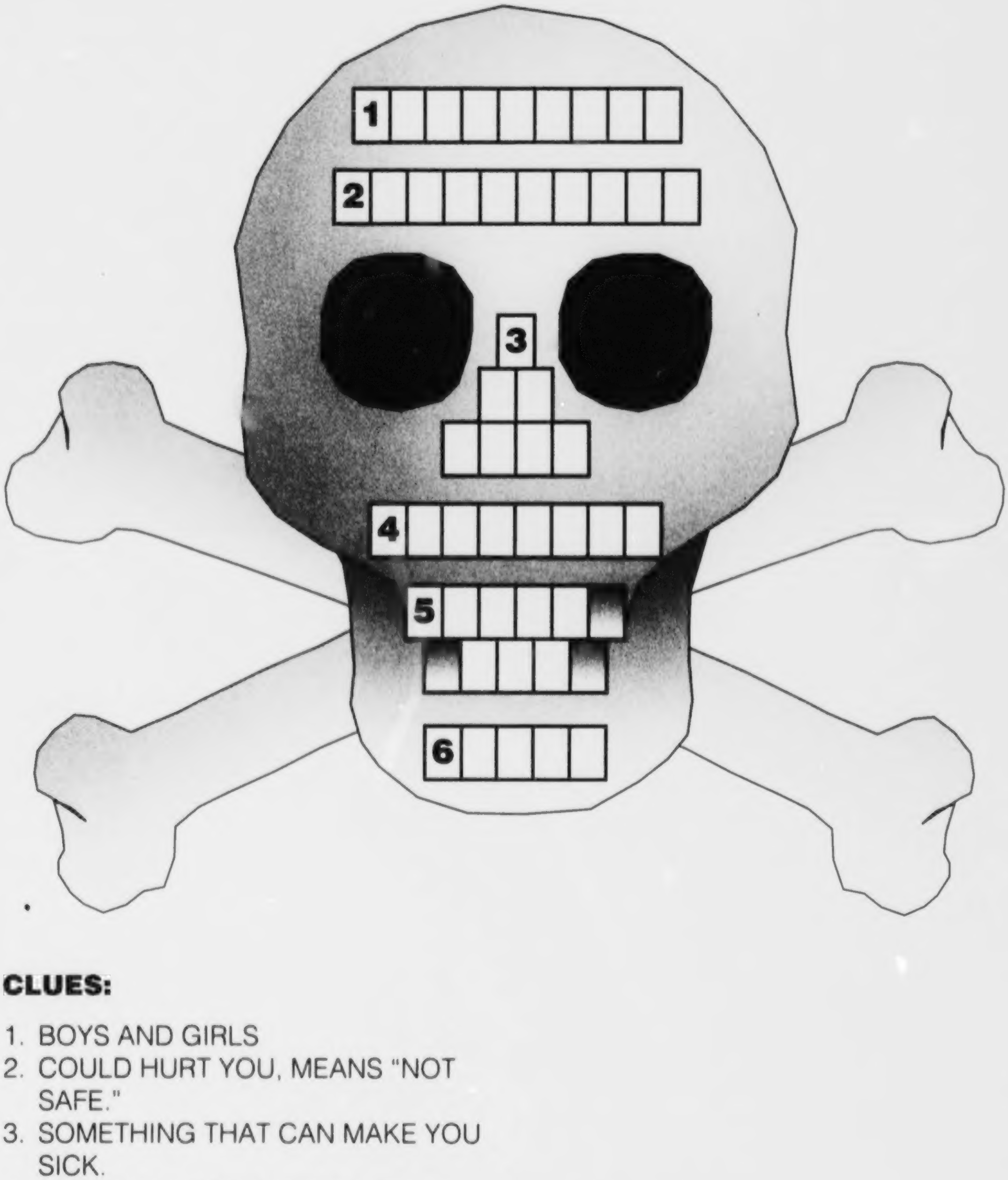
Grades:
K - 3rd

Time:
20 - 30 minutes

Materials:
- Copies of attached word puzzle

Adapted from ***TOXICS IN MY HOME? YOU BET!, 1984***

Word Puzzle



CLUES:

1. BOYS AND GIRLS
2. COULD HURT YOU, MEANS "NOT SAFE."
3. SOMETHING THAT CAN MAKE YOU SICK.
4. MEANS "WATCH OUT" OR "BE CAREFUL."
5. STAY AWAY
6. O.K., WILL NOT HURT YOU.

WORDS TO USE:

WARNING, KEEP OUT, POISON, CHILDREN, DANGEROUS, SAFE

POISON THAT LOOKS LIKE FOOD

BACKGROUND

Poisonous substances can sometimes be mistaken for food. These harmful materials cannot be determined by sight, smell, or taste. Disinfectant can look like apple juice; radiator coolant is sweet to the taste; pesticide residue on fruits and vegetables has no taste or odor.

We depend upon others to inform us of whether a substance is safe or not. In this instance, children depend upon adults to inform them if a substance is safe to eat.

Listed at the end of the activity is a list of "Look-Alikes", foods and products that resemble one another. Pick out about four "look-alikes", both the food and the product for a display.

NOTE: Allergic reactions could occur if the students are allowed to smell the products.

One or two products should be placed in a food container. All containers should be capped or covered in plastic.

Arrange a display of some unsafe products before class begins. Keep their safe counterparts out of sight.

Goals:
Students will:
- realize that some toxic products appear safe to eat.
- understand that they should never put things in their mouths without the permission of an adult.

School Subjects:
Social Studies, Science

Grades:
K - 3rd

Time:
30 minutes

Materials:
- Four or more "Look-Alikes"

PROCEDURE

1. Tell the students that now that they have learned how some things around the home can hurt them or make them sick, today they are going to learn how some unsafe products can fool them into believing they are safe.

2. Tell the students that things are not always what they seem to be. Show the children the display of unsafe products. Keep the safe products out of sight. Instruct the students to look at the display and guess what the products are. Have the students file by and look at the display. DO NOT allow touching. When the students are through, point to the products, one at a time, and ask what they "look like". Encourage the students to expand their answers such as, "It's is a soda bottle so it must be soda, and therefore, safe to drink". Accept all answers. If a child guesses the actual unsafe product, just accept this answer with all the rest.

3. When all the products have been discussed, tell the students that the products just fooled them (or some of them). Identify the products to the students and bring out their corresponding safe

"look alikes". Ask: How were you fooled by the unsafe product? Have them identify exactly what characteristics led them to believe that the substance was a safe one. After the discussion, be sure to lock away both the safe and unsafe products.

4. Discuss that just because some unsafe products can fool them, it is important not to ever put anything in their mouth unless an adult gives them permission.

DISCUSSION/TEST QUESTIONS

Suppose you were very thirsty and found a soda bottle where your parents had been painting a bookshelf in the garage. What would you do? Why?

Suppose you were playing in the back yard with your baby brother and you saw him put something in his mouth. It looked like food but you were not sure and your mother had just finished putting some poisons out to kill some garden bugs. What would you do? Why?

LOOK-ALIKES

Not Safe	**Safe**
moth crystals	*rock candy*
ant and roach paste	*peanut butter*
bleach, drain opener	*water*
slug killer	*cereal*
disinfectant	*apple juice*
red furniture oil	*cherry soda*
detergents	*powdered milk*
lemon furniture oil	*lemon soda*
mothballs	*marshmallows*
radiator flush	*canned soda*
medicine in tube	*toothpaste*
pills (colored)	*candy*

Adapted from **TOXICS IN MY HOME? YOU BET!, 1984, and HAZ MAN, 1988**

SAFETY THE HOUSEKEEPER

Goals:
Students will:
- identify and name some common household products that are hazardous if not used and disposed of properly.
- learn the location of hazardous and poisonous materials that may be in their homes.
- recognize that poisons should be kept out of reach of children

School Subject:
Science, Social Studies

Grades:
2nd - 4th

Materials:
For the teacher:
- Magazine photos of household products
- Overhead of Safety's House

For each student:
- The drawing of two shelves
- The pictures of household products

PROCEDURE

1. Hang up the pictures from magazines of household products and goods in front of the classroom.

2. Tell the students that there are things found in the home that are safe to eat and some things that are not safe to eat. Many things that are not safe to eat can make us very sick and are called poisons. Tell the students that there are some products that are used in the home that may be hazardous if not handled and disposed of carefully. Explain that hazardous means dangerous and that hazardous substances are likely to cause harm to the environment or to humans because they are either toxic (poisonous), flammable (quickly burnable), reactive (explosive), or corrosive (substances that rapidly eat into or dissolve away what they touch).

3. Have the students look at the pictures that are hanging up in front of the classroom. **Ask:** What products would you eat and which would you not? Allow 5 minutes for the discussion. Encourage the students to expand on their reasons, such as, "That's medicine and we should only eat what a parent gives us to make us feel better", or "That's a carrot, and we eat that for lunch".

4. Now tell the students that they are going to hear a story about Safety the Housekeeper and tell them that they will be taking a tour of Safety's house. Explain that Safety lives in the house with a little boy and girl. As Safety was cleaning the house one day, he noticed that someone left some things out that could hurt children if they ate them. So Safety decided to go through the whole house picking up harmful products and putting them on high shelves where children couldn't reach them and harm themselves.

5. Show the transparency of Safety's house. Tell the students that this is Safety's house and that you will all look for what Safety found and decide which items were picked up and put on higher shelves. Direct the students to look at each room individually and ask: What is in this room that could hurt children? If they do not know, help them out with hints, such as, "Look under the sink. What do you see?" If they do not recognize a product, help them out with hints, such as "What do you use to scrub out your bathtub?" When the

children say that Safety should pick up an item, put an X over it. You will put an X over the bubble bath and cleanser in the bathroom; in the bedroom, an X over the pills; an X over the furniture polish in the living room; an X on the oven spray and drain opener in the kitchen; and in the garage, an X over the paint, charcoal lighter, motor oil, and laundry soap.

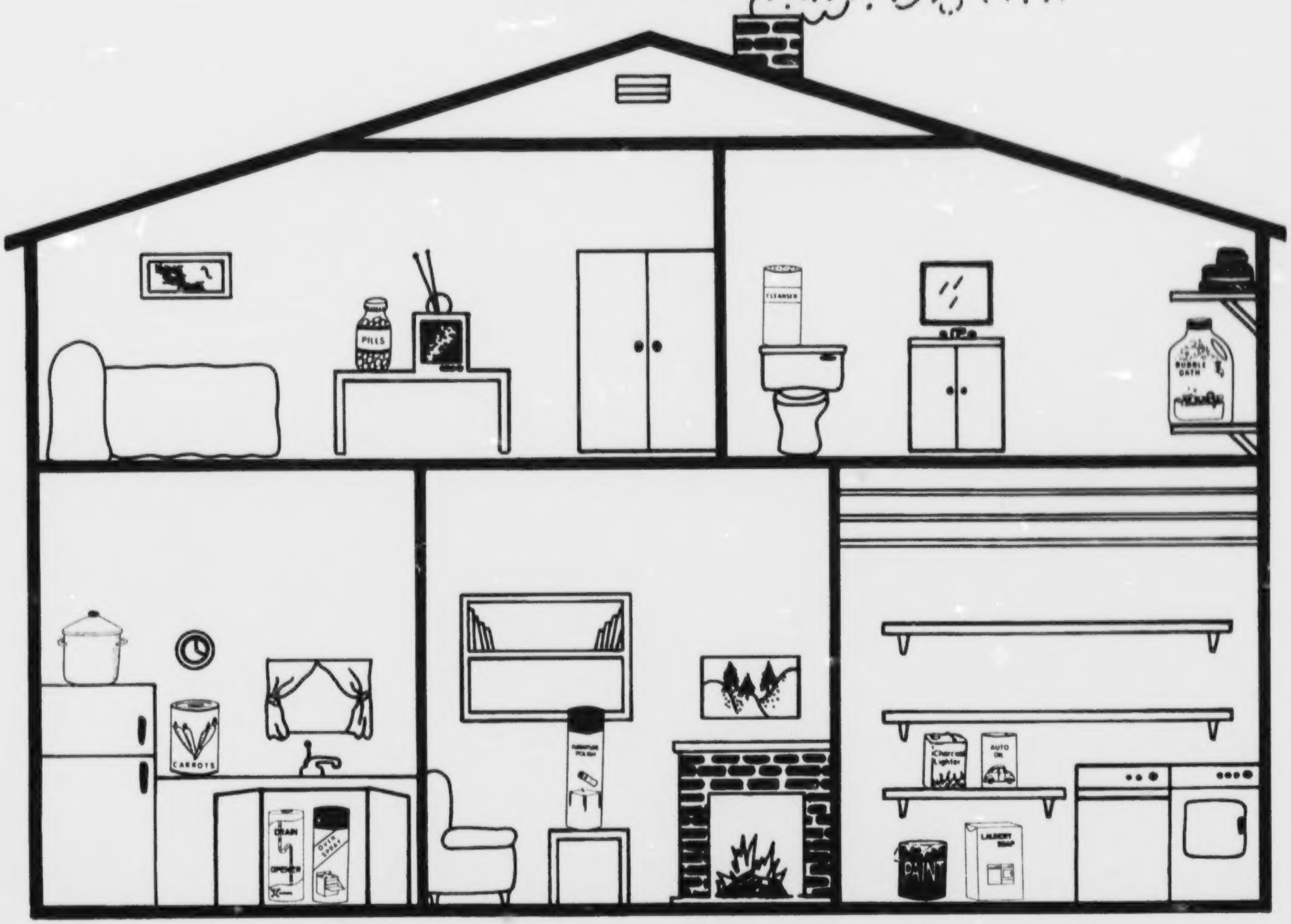
Explain what the products do and some of the dangers of the products as you X them out. For example, drain opener unclogs drains, but can burn the skin if touched and the lungs if breathed. Oven sprays clean the oven, but could harm the eyes if sprayed on them. When all of the potentially harmful products are X'ed out, ask the students if Safety has made the house safe for the children.

6. Now tell the students that they are going to play a game. Tell them that they will get some pictures of things that Safety needed to put away. Safety has two shelves to put things on. He wants to use the very high shelf for things that should be kept out of reach of children. The low shelf is for things that children can be around.

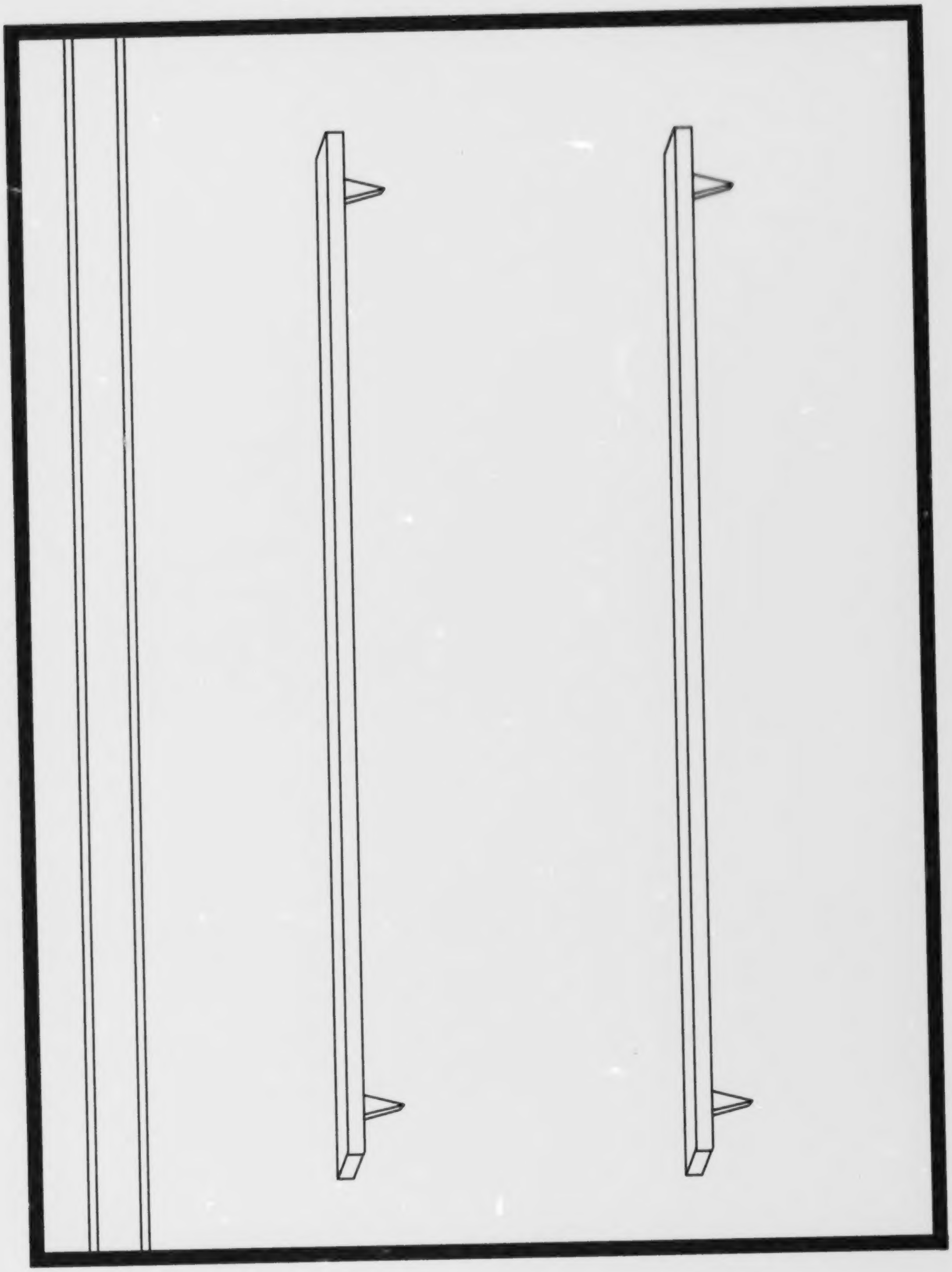
7. Pass out the picture of the two shelves and the products. Tell them that they can cut out the products and tape or glue them on the appropriate shelves. Emphasize that products placed on the high shelf are put out of the reach of children because they are potentially harmful.

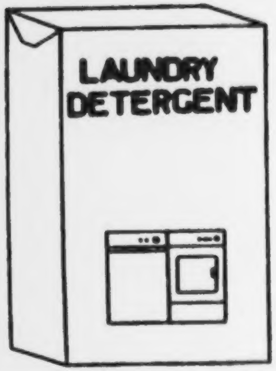
Adapted from ***TOXICS IN MY HOME? YOU BET!, 1984, and A-WAY WITH WASTE, 1985***

SAFETY'S HOUSE


PILLS
CLEANSER
BUBBLE BATH
CARROTS
DRAIN OPENER
OVEN SPRAY
FURNITURE POLISH
Charcoal Lighter
AUTO OIL
PAINT
LAUNDRY SOAP

From **TOXICS IN MY HOME? YOU BET!, 1984**

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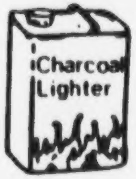
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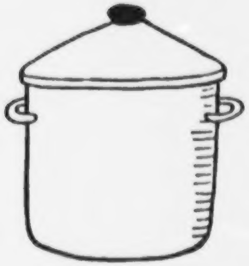
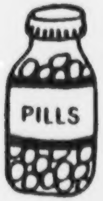
Lighter

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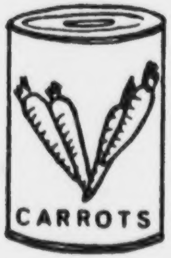
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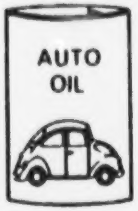
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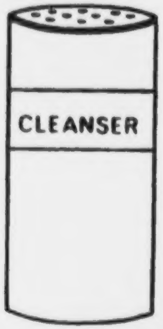
OIL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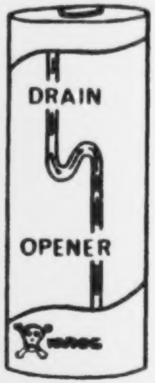
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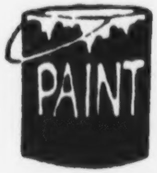
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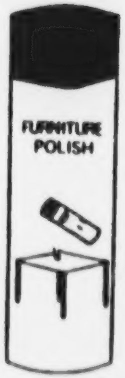
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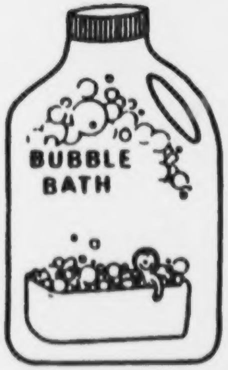
POLISH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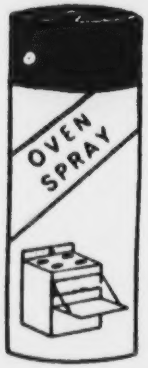
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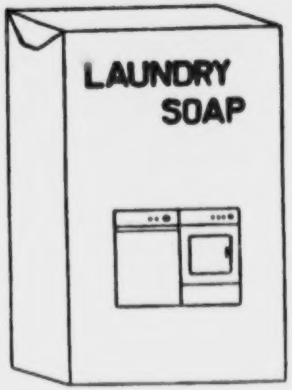
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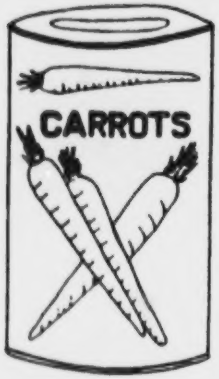
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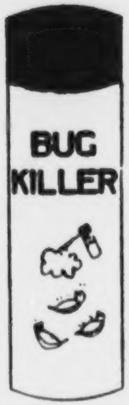
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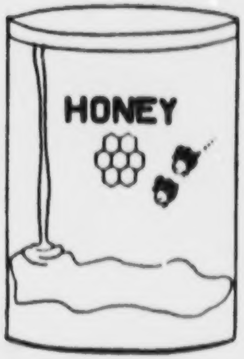
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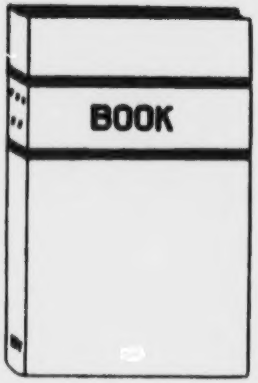
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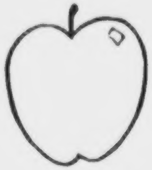

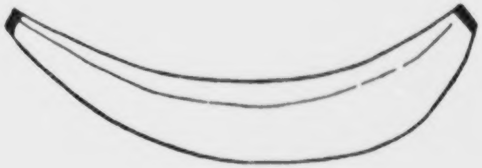

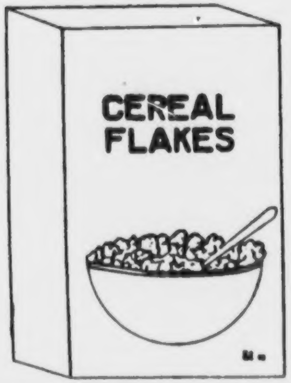
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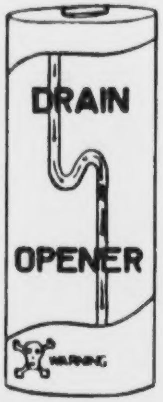
FLAKES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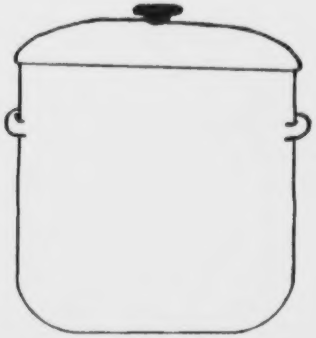
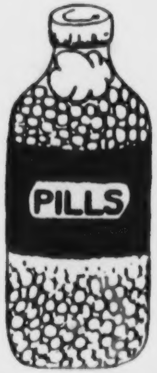
OPENER
WARNING

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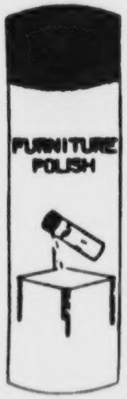

FURNITURE
POLISH

THE BIG THREE OF TOXICS

Routes of Exposure

Goals:
Students will:
- identify three ways in which the body is affected by unsafe use of household substances (ingestion, inhalation, skin absorption)
- identify unsafe situations that lead to poisonings

School Subject:
Science, Social Studies, Health

Grades:
4th - 6th

Time:
Forty Minutes

Materials:
Overheads:
"Eating/Drinking", "Breathing", and "Skin Absorption", and Teacher Answer Sheet

PROCEDURE

1. Introduce the subject by asking the students to name three ways that hazardous substances might enter their bodies and cause injury or illness. Solicit answers until the following three responses are given:

a. eating/drinking (ingestion)
b. breathing (inhalation)
c. skin contact (absorption)

Write these responses on the chalkboard.

2. Tell the class that they will be learning about unsafe circumstances that might result in hazardous substances being eaten, breathed, or absorbed into the skin.

3. **Ask:** How might unsafe situations result in hazardous items being eaten or drunk? Show the overhead "Eating/ Drinking". Read aloud the first item and the unsafe situation. Have the students discuss what they think can happen. List some of the ideas in the box "What Can Happen". Complete the other items the same way. Students can also be divided into groups to discuss a certain product and what can happen with the scenario.

4. Ask the class how hazardous chemicals can be breathed into the lungs. Next show the overhead "Breathing". Inform the class that people often get sick from working with certain chemicals in closed-quarters by breathing fumes. Ask students if they know of a precaution used when working with fume-producing chemicals (work only with good ventilation or wear a respirator). Hazardous fumes are also created from mixing certain products such as chlorine bleach and ammonia or bleach and toilet bowl cleaners.

People also breathe in chemicals from sprays. The fumes can irritate and damage the eyes, skin, and lungs. They can also enter the bloodstream through the lungs and cause internal harm. Aerosol cans are potentially dangerous. They can explode under high heat and should never be placed in direct sunlight, near stoves, etc.

6. Now discuss situations where chemicals can be absorbed through the skin. Show the "Skin Absorption" overhead. Inform the students that some chemicals can pass through the skin when touched and get into the body. Some chemicals can cause a burning sensation or irritate the skin.

Oven cleaners and drain openers are very corrosive and can cause burns and irritations to the skin. It is very important to read product labels. If the label calls for protective clothing, make sure it is worn. If the product says "Keep out of eyes" "Avoid skin contact" or "Vapor harmful", then it is a very dangerous chemical. Therefore, to use this chemical, protective safety glasses should be worn, with gloves, long pants and shirts, and heavy shoes to avoid contact; and be used outdoors in an extremely well ventilated area to avoid harmful vapors.

7. After finishing with "Skin Absorption" have the students make a list of safety precautions for using hazardous household chemicals. Some suggested rules:

- *Never leave household hazardous substances unattended if children or animals are present. Immediately after using hazardous items, seal them and put them out of reach of children.*
- *Never place potentially hazardous products in food or drink containers. Even better, do not remove the chemical from its original container. The original label will provide its name, chemical content and precautions.*
- *Never take medicines not administered by an adult.*
- *Never use potentially hazardous items in areas that are not well ventilated.*
- *Never mix two different products.*
- *Never put aerosol cans near heat or flame.*
- *Always wear protective clothing when working with potentially hazardous chemicals.*
- *Always read the container for any warnings regarding how to use, or not use, the product.*

Adapted from ***TOXICS IN MY HOME? YOU BET!, 1984***

TEACHER ANSWER SHEET

Eating/Drinking

Drain opener – A young child might drink it. NOTE: Drain openers are highly corrosive and should never be allowed to splash or touch skin or eyes.

Lemon furniture oil – Someone might think the furniture oil was apple juice or lemon soda and drink it. NOTE: Children are lured by the pretty colors and scents of some products. Never underestimate what a child will eat or drink.

Pills – Young children might think the pills look like candy. People could also hurt themselves very badly by taking medicine prescribed for someone else. NOTE: Medicines should never be taken unless given by an adult.

Antifreeze – Pets have died after drinking from a puddle of antifreeze. NOTE: Animals are attracted to the sweet taste of the chemical in antifreeze called ethylene glycol.

Breathing

Aerosol air fresheners / deodorizers – Residents in the home may feel sick from breathing the fumes in closed quarters. Also, the can might explode by keeping it near a source of heat. NOTE: most air fresheners and deodorizers work by either desensitizing your sense of smell a little, coating your nasal passage with an oily film, or masking the unpleasant odor with another odor.

Chlorine bleach and ammonia – Mixing chlorine bleach and ammonia releases a toxic gas. This gas has sent people to the hospital, caused fainting and even death. NOTE: The fumes, depending on the amount of product used, can result in eyes, throat, and nose irritations and breathing difficulty. Products should never be mixed unless specific instructions to do so are found on the product label.

Furniture stripper – Solvents used in these products dry easily but the vapors still linger in the air and are breathed unless there is good ventilation and fresh air. Using a fan in closed quarters will only recirculate bad air. NOTE: Not all solvents have strong enough odors to warn you that you are breathing them. Possible warning signs include itchy or burning eyes and skin; coughing; nausea; headache; dizziness or sleepiness. The long term hazards associated with some solvents include liver and kidney problems, birth defects, and nervous disorders.

Skin Absorption

Pesticides – The chemicals can penetrate the socks and be absorbed through the skin. NOTE: The complete impact each pesticide, or any chemical, has on each person's health is not known—especially the long-term effects. Also, people have different sensitivities to different chemicals.

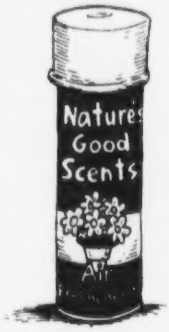
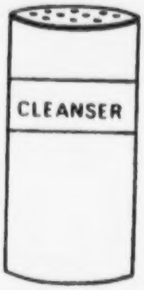
Degreaser – Solvents can dissolve skin oils and cause irritation and dryness. Solvents can also pass through the skin into the bloodstream where there is a potential for damage to other parts of the body. Hands should not be washed with solvents unless the container says so. NOTE: Directions for use should always be read before using a potentially hazardous product. Solvent vapors or splashing liquids can cause severe eye damage, particularly if the victim wears soft contact lenses. The lens can keep the vapor close to the eye.

Oven cleaner or drain opener – The chemicals in these products could cause the skin to burn or develop a rash. NOTE: Oven cleaners and drain openers contain very strong, corrosive chemicals. Any skin and eye contact should be washed immediately and thoroughly with water.

Eating/Drinking

Potentially Hazardous Product	Unsafe Situations	What Can Happen
Drain Opener DRAIN OPENER	When the doorbell rang, a bottle of drain opener was left on the bathroom floor. A baby was playing nearby.	
Lemon Furniture Oil FURNITURE POLISH	When polishing some furniture, the cap to the bottle was lost and the polish was placed in a glass near the sink.	
Pills 	After taking a variety of pills under a doctor's order, the medicine was placed on a nightstand.	
Anti-freeze ANTI FREEZE	After the antifreeze was changed in the car, it was thrown in the ditch in front of the house.	

Breathing

Potentially Hazardous Product	Unsafe Situations	What Can Happen
Aerosol/Air Freshener/ Deodorizers  	The smell from cooking fish was unpleasant. To take the smell away, all the windows were closed and an air freshener was sprayed in the house. The can was then put away—on top of the hot water heater.	
Cleanser and Ammonia  	The bathroom tile wouldn't come clean using chlorine bleach cleanser so it was decided to mix some ammonia with the cleanser to make a stronger product.	
Furniture Stripper FURNITURE STRIPPER	Your neighbor decided to strip the paint off an old chair. He started working on the chair in a small room in his garage. Rather than open the door and windows for air, he turned on a fan.	

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Skin Absortion

Potentially Hazardous Product	Unsafe Situations	What Can Happen
Pesticides Pure n' Simple PEST DEATH PESTICIDE	**To kill some ants in the kitchen, an insect killer was sprayed on the floor. Residents of the house had a habit of walking around in their stocking feet.**	
Degreaser (used to dissolve oil and grease) AUTO DEGREASER	**After working on the car engine, a degreaser was poured over the mechanic's hands to take off the grease. The container said, "Avoid skin contact" but he never bothered to read the fine print.**	
Oven Cleaner FOAMY OVEN CLEANER	**Although the product called for the use of rubber gloves, a housekeeper felt they were too clumsy and decided to clean the oven without them.**	

FINDING COMMUNITY RESOURCES

Goals:
Using telephone books as a source for locating community services, students find and record resources for handling various situations concerning hazardous substances.

School Subject:
Science, Social Science, Math, Language Arts

Grades:
4th - 6th

Time:
2 days

Materials:
- Phone books (both white and yellow pages) for each pair of students
- Worksheets, one per pair of students
- Chalkboard

PROCEDURE

Day One

1. Pair up students and give each pair a phone book (both white and yellow pages). Introduce the activity by telling students that they are going to use these books to find ways to get information about hazardous substances and about what to do when these substances pose a threat. Tell students that first they are to see what they can find out about the phone book.

2. After giving students a few minutes to look through the book, ask, "What kinds of things did you find out about the phone book?" Record students' responses on the board. Ask, "What is the difference between the white and yellow pages? When would it be better to use the white pages? When would it be better to use the yellow pages? Where would you find government numbers? Are all emergency numbers listed there? What other kinds of information does the phone book contain?"

3. Have students practice using the phone books by telling them, "Let's suppose your dog swallowed some ant poison and is sick. You need to call the veterinarian. Find Dr.___'s phone number in the phonebook." (give the name of a veterinarian in your phone book). Discuss with students how they found the veterinarian's phone number. Ask, "What other ways might we have found the number? Whom else might you have called?"

4. Ask the class, "Whom would you call to get information about how aspirin can affect your health?" List responses on the board. "What words could you look up to get ideas for other resources?" List these. "Under what words might you find city or county agencies that could help with the problem?" List these.

5. Have different students look up resources using different paths. After giving students time to research, have them share their findings.

Day 2

6. Tell students that they will search through a telephone book to find the name and phone number of a business or person that would be able to help them with five problems. Tell students that they will have plenty of time to tackle all five problems and that this is not a race.

7. Explain to students that each answer must:

- State the full name of the resource (for example, "Albany Public Library", not just "library".
- State a person's occupation as well as his or her name if an individual is given as a resource
- Name a resource that is able to give direct answers to the problem, not just tell you where else to call (for example, "my father" is not acceptable).

8. Divide the class into pairs. Give each pair a phone book (both white and yellow pages) and a "Let Your Fingers Do the Walking" copycat page. Allow enough time for most of the class to finish (about 20 to 30 minutes). If pairs finish early, you might challenge them to find and list a second kind of resource for each problem.

Adapted from ***TOXICS: Taking Charge, 1989***

LET YOUR FINGERS DO THE WALKING

Name: ______________________

Number

1. Whom would you call to get help for a small child who has swallowed a cleaning solution?

   ______________________ ______________

2. Whom would you call to get help for a friend who is sick from a drug overdose?

   ______________________ ______________

3. Whom would you call to get information about what ingredients are in a laundry detergent?

   ______________________ ______________

   ____

   ____

4. Whom would you call to get information about how to dispose of a hazardous chemical found at school?

   ______________________ ______________

   ____

   ____

5. Whom would you call to report that a truck driving down your street has spilled an unknown powder onto the road?

   ______________________ ______________

   ____

6. (Optional) Whom would you call to answer your question from the "How Do You Feel?" activity? Write your question, then whom you would call. (next activity)

   ______________________ ______________

   ____

   ____

from ***TOXICS: Taking Charge, 1989***

LET YOUR FINGERS DO THE WALKING

Teacher's Reference Sheet

Below are some posible answers for the copycat page questions. These are given to help you guide discussion. Students will find other answers, and local services and businesses.

Number

1. Whom would you call to get help for a small child who has swallowed a cleaning solution?
   Poison Control Center, ambulance or 911, physician __________

2. Whom would you call to get help for a friend who is sick from a drug overdose?
   Ambulance or 911, drug line, Poison Control Center __________

3. Whom would you call to get information about what ingredients are in a laundry detergent?
   Consumer protection coordinator, consumer action line, U.S. Consumer Product Safety Commission, laundry product distributor __________

4. Whom would you call to get information about how to dispose of a hazardous chemical found at school?
   Industrial waste disposal companies, California State Department of Health Services, local garbage collection department __________

5. Whom would you call to report that a truck driving down your street has spilled an unknown powder onto the road?
   California Highway Patrol, 911, County Sheriff, California State Department of Health Services __________

6. (Optional) Whom would you call to answer your question from the "How Do You Feel?" activity? Write your question, then whom you would call. (next activity)
   The environmental health divisions of local, county, and state health departments can answer a variety of questions. __________

from **TOXICS: Taking Charge, 1989**

Name: ____________________

Emergency Numbers

FIRE Telephone ____________________

POLICE Telephone ____________________

AMBULANCE Telephone ____________________

(Many communities have a "911" emergency service number for police, fire, and ambulance)

POISON CONTROL CENTER Telephone ____________________

DOCTOR
Name ____________________
Address ____________________
Telephone ____________________

NEAREST HOSPITAL EMERGENCY ROOM
Name ____________________
Address ____________________
Telephone ____________________

NEAREST RELATIVE
Name ____________________
Address ____________________
Telephone ____________________

NEIGHBOR OR OTHER RESPONSIBLE ADULT
Name ____________________
Address ____________________
Telephone ____________________

from **TOXICS: Taking Charge, 1989**

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HOW DO I FEEL?

Goals:
Students will:
- describe how they feel about what they have learned on the topic of hazardous substances.

School Subject:
Science, Language Arts

Grades:
3rd - 6th

BACKGROUND

Students may feel overwhelmed by what they know and have learned about hazardous substances; it might be frightening or worrisome to them. The issues involving these substances are especially controversial because they evoke strong emotional responses from many people.

In this activity students look at some emotional aspects of hazardous substance issues and express how the things they have learned make them feel. It is important that students be allowed to express their feelings openly, without fear of rejection or ridicule. The teacher's role is to facilitate discussion. It is important that the teacher confirms for students that their feelings are legitimate. It is natural and normal for students to feel the way they do, and the teacher can affirm this. Although it may be tempting to try to alleviate uncomfortable feelings that students may have, the subject of hazardous materials is a complex set of issues that are not resolved easily. The teacher can use the activity as a forum to acknowledge the complexity of the issues and the kinds of feelings they evoke in everyone.

PROCEDURE

1. Divide the students into groups of four. Give groups ten minutes to list things that they have learned about hazardous substances on a piece of scratch paper. Have groups share with the class what they have listed, and record their responses on the board.

2. Talk with students about "feeling" words (e.g., angry, mad, sad, glad, joyful) and help them generate some of these words, writing them on the board. Distribute scratch paper and ask students to write down feeling words that describe how they feel concerning what they have learned about hazardous substances. The teacher should also do this.

3. Open the discussion by stating "Recently we have been examining harmful items that are in our homes. We have considered the importance of being careful with unknown substances, and we have learned about reading and following labels on household products. Today you have identified some of the things you know now about hazardous substances, and we have thought about how what we know makes us feel. What are some of the words that describe how you feel?"

As the students share a word or phrase, rephrase what they have said and confirm the students' feelings. Be sure to look at the student while paraphrasing and confirming his/her statement. If necessary, remind students that all feelings are legitimate and to listen with respect to others' responses.

After all students how wish to share their feelings have had the opportunity to do so, the teacher may want to share their own feelings about hazardous substances. Summarize the discussion by listing some of the words students have used to describe how they feel about these substances.

4. Give students new scratch paper. Allow them 10 minutes to write down any questions they have about hazardous materials - anything they would like to know more about, spend more time on, or are confused about. Collect the responses. Tell students that their questions will be looked over and that they will be helped to look for answers for their questions. Remind students that because hazardous substances is such a complex subject, some of their questions may be difficult to answer easily.

Adapted from ***TOXICS: TAKING CHARGE, 1989***

HAZARDOUS WASTE HOT POTATO

BACKGROUND

Many common household products contain hazardous substances. When these wastes are discarded in landfills, the unused portions can accumulate and over time contaminate water supplies or emit harmful vapors. Because of tightening hazardous waste disposal regulations; the closure of landfills; and the realization that these wastes present health and environmental problems; our public officials are faced with the problem of what to do with wastes from a variety of sources that in the past were assumed to be harmless. This activity introduces the many problems associated with hazardous wastes for the benefit of people and the environment.

Study the three overheads before teaching this lesson to familiarize yourself with the terms used to describe hazardous substance characteristics and toxicity ratings.

The four disposal options and products in the game are:

Recycle:
auto battery, transmission fluid, etc.
Trash for the landfill:
empty aerosol can, empty cleaner container, etc.
Hazardous waste collection:
rat poison, oven cleaner, etc.
Flush down the drain:
ammonia house cleaner, drain cleaner, etc.

Be able to explain why a sewer line can take certain items that a septic tank cannot. (The bacteria in the septic tank will be killed by these toxic household items, where the sewage treatment plant chemically breaks down the toxics.) This is one reason not to dump things down the sink. Household hazardous waste collection programs safely store, reuse, treat or dispose of a community's household hazardous waste.

Goals:
Students will:
- learn what characteristics make a substance hazardous
- learn the signal words for hazardous substances
- learn the definitions for terms related to household hazardous substances
- recognize their responsibility for safe disposal of household hazardous waste

School Subject:
Science, Social Studies

Grades:
4th - 6th

Time:
1 class period

Materials:
- See list in activity

Materials:

For the teacher:
- Four examples of household hazardous products. Choose one from each of the listed disposal options.
- Four depositories marked with different disposal option for each team. Use boxes, bags, etc.
- Overheads: Hazardous Substances , Hazardous Substance Toxicity Chart, Hazardous Substance Characteristics.

For each team of students:

- 10 "hot potatoes" (potatoes, eggs, blocks, etc.)
- 10 household product sticker labels for the 10 household products
- 10 toxic warning stickers
- 5 corrosive warning stickers
- 5 flammable warning stickers
- 2 irritant warning stickers

PROCEDURE

1. Explain the dangers of household hazardous substances to the class. Tell them, for example, that 125 people a day in the United States are poisoned by pesticides.

2. Show each of the four household hazardous product examples to the class. (Be certain that the containers are empty, the lids taped shut, and safely sealed in a plastic bag.)

3. Read aloud to the class any warnings on the labels.

4. Show the overhead "Hazardous Substance Toxicity Chart". Explain the three degrees of toxicity. Ask the class if they have items in their homes that meet the different degrees of toxicity.

5. Show the overhead "Hazardous Substance Characteristics". Carefully go over the definitions.

6. Ask the students to make a list of five hazards in their own homes. Ask how are the items stored? Which hazardous signal words would you find on these items? What do you do with these items when you are finished with them? (Examples may be: throw in trash, dump on ground, flush down drain, store in basement or garage, share usable products with neighbors.)

7. Show the overhead "Hazardous Substances". Outline to the class each of the four disposal methods on the overhead (recycle, hazardous waste collection, trash for landfill, and flushing down a toilet.) Explain here the difference between a septic tank and a sewer line system to a treatment plant.

8. Now cover the overhead. Ask the class which of the four disposal methods they think is appropriate for each of the display items.

9. Tell the class they will be given an opportunity to work as teams to decide the proper disposal of ten household hazardous waste items. Then explain the rules of the game from the attached sheet. They may be given a copy of the "Hazardous Substances" overhead.

Play the "Household Hazards Disposal Game".

Adapted from ***A-WAY WITH WASTE, 1990***

Hazardous Substances

ITEM	WHY HAZARDOUS	DISPOSAL
Auto battery	Corrosive, toxic	Recycle
Drain cleaner	Corrosive, toxic	Give to someone to use up or flush small amounts down drain*
Empty aerosol can	Flammable, toxic	Place in trash for landfill
House cleaners with ammonia	Corrosive, toxic, irritant	Give to someone to use up or flush down drain
Oil base paint	Flammable, toxic	Give to someone to use up or Hazardous Waste Collection
Oven cleaner	Corrosive, toxic	Give to someone to use up or Hazardous Waste Collection
Rat poison	Toxic	Hazardous Waste Collection
Roach and ant killer	Toxic	Hazardous waste Collection
Transmission fluid	Flammable, toxic	Recycle
Used motor oil	Flammable, toxic	Recycle

**Only if connected to a sewer system; otherwise give to hazardous waste collection.*

Household hazardous waste disposal recommendations are subject to change as new information is obtained about chemical products. To receive a free brochure about household products, safer substitutes and recommended disposal options call the California Department of Health Services, Toxic Substances Control Program at 916-322-0476.

From **A-WAY WITH WASTE**

Hazardous Substance Toxicity Chart

Warning Word	Toxicity[4]	Examples
CAUTION	Moderately Toxic Lethal dose: An ounce to a pint	Ammonia, Most paints, Floor polishes
WARNING	Very Toxic Lethal dose: A teaspoon to a tablespoon	Antifreeze, Bleach, Some fertilizers, Many pesticides
DANGER	Extremely Toxic Lethal dose: A taste to a teaspoon	Rat poison, Mercury batteries, Some pesticides and weed killers, Paint thinner, Drain opener, Some oven cleaners

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[4] *Robert E. Gosselin, et al. Clinical Toxicology of Commercial Products. Baltimore, MD.: Williams and Wilkins 1984, p. 1-2.*

From **A-WAY WITH WASTE**

HAZARDOUS SUBSTANCE CHARACTERISTICS

TOXIC

A substance that is potentially harmful to human health, can cause cancer or birth defects, and can contaminate, harm or kill fish or wildlife.

Examples: Lead, mercury, pesticides.

REACTIVE

An unstable substance that reacts strongly (including explode) if exposed to heat, shock, air, or water.

Examples: Bleach and ammonia when mixed together; munitions.

CORROSIVE

A highly acidic or base substance that corrodes storage containers or damages human tissue if touched.

Examples: Battery acid, bathroom cleaners, pool chemicals.

IGNITABLE

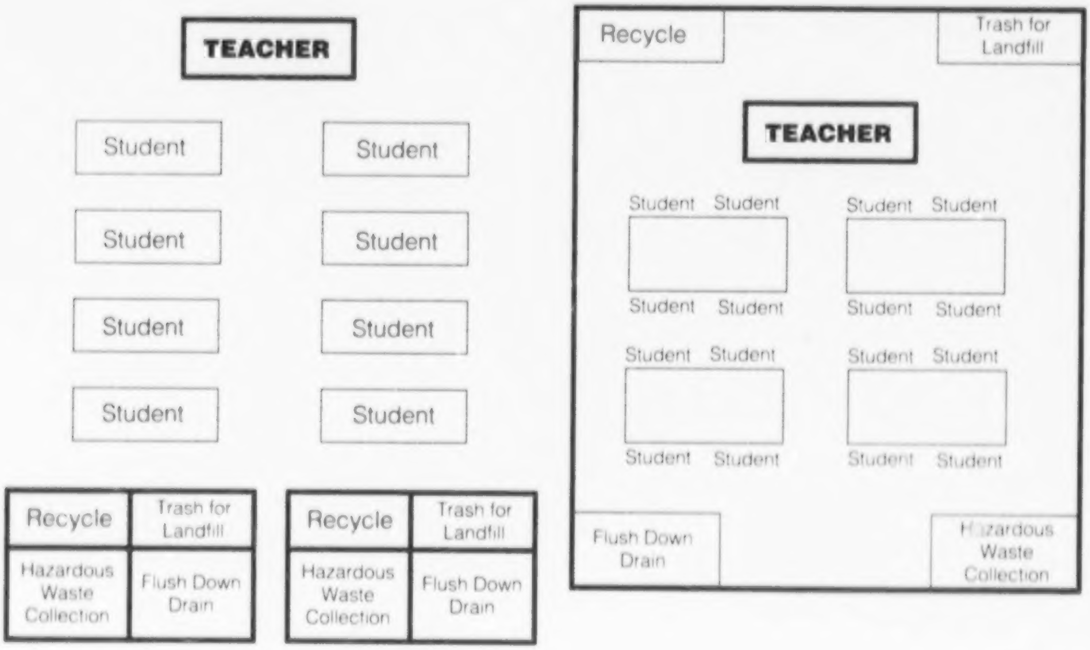
A substance that can explode, catch on fire, or emit toxic fumes or gases into the environment.

Examples: Fuels, some cleaning fluids, some furniture polishes.

CALIFORNIA DEPARTMENT OF HEALTH SERVICES, TOXIC SUBSTANCES CONTROL PROGRAM

Household Hazardous Waste Disposal Game

Class Arrangement Options For Game


TEACHER
Student
Student
Student
Student
Student
Student
Student
Student
Recycle
Trash for Landfill
Hazardous Waste Collection
Flush Down Drain
Recycle
Trash for Landfill
Hazardous Waste Collection
Flush Down Drain
Recycle
Trash for Landfill
TEACHER
Student Student
Student Student
Student Student
Student Student
Student Student
Student Student
Student Student
Student Student
Flush Down Drain
Hazardous Waste Collection

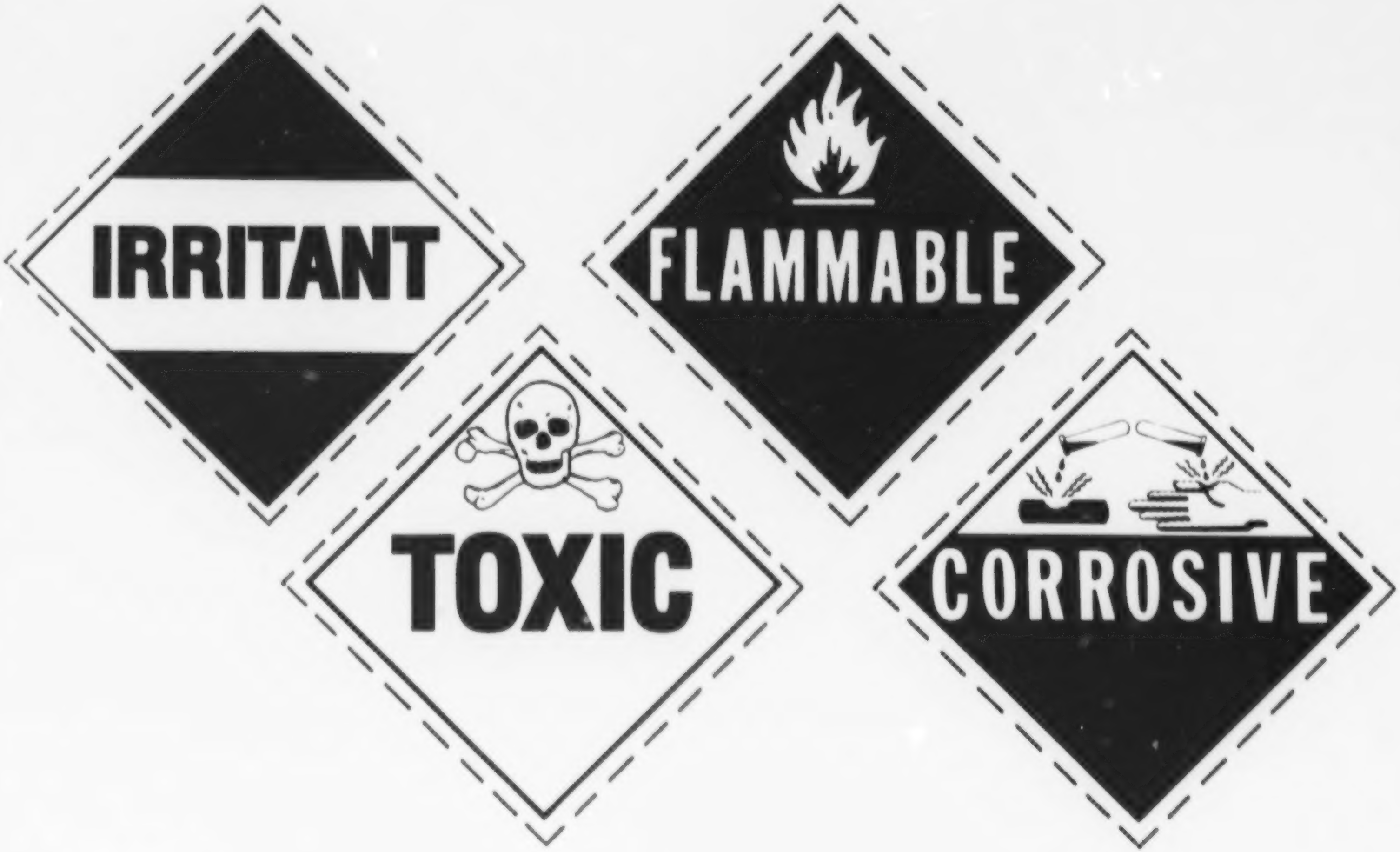
Rules

1. Each team has ten hot potatoes, ten household product name stickers, and a pile of warning word stickers to attach to the potatoes.
2. The team has a twenty-five second time limit to place the product name on the potato, apply the proper warning stickers and place the potato in the proper depository.
3. A designated team member applies the household product name sticker and the appropriate warning label(s).
4. If the potato is not in the depository at the end of the time limit, the person holding the potato must keep it at their desk. (This represents littering.)

Keeping Score

1. One point for each proper warning sticker for each product.
2. Two points for placing the potato in the proper depository.
3. Two points are deducted for placing the potato in the wrong depository.
4. Two points are deducted for littering.
5. One point is deducted for applying an incorrect label.
6. The team with the most points after the disposal of all ten potatoes wins.

From **A-WAY WITH WASTE**


IRRITANT
FLAMMABLE
TOXIC
CORROSIVE

TOXIC-FREE BINGO

Goal:
Students will identify safe substitutes for some hazardous products and learn where they can be obtained.

School Subject:
Science, Social Studies, Home Economics

Grades:
4th - 8th

Time:
40 minutes

Materials:
- Advertisements from magazines and newspapers showing toxic products
- 4 x 4 grids (bingo cards), one for each student
- List of safer substitutes
- Beans or small markers
- Master cards

PROCEDURE

1. Introduce the lesson by asking students to name some potentially toxic products used in the home to:

    1) clean and freshen the house
    2) take care of the yard and garden

List their responses on the board under "1" and "2".

2. Display advertisements or pictures of hazardous household substances. Have the students observe the packaging and slogans used by each company to sell their product. Ask the students to recall any advertisements they have seen on TV. What was the slogan, jingle or gimmick used to sell that particular product? Why might a consumer buy these toxic products? Discuss.

3. Explain to the students that many potentially hazardous items that we purchase are not always necessary, and are sometimes expensive. There are safer substitutes for some of these products available at most grocery stores.

4. Ask students if they can think of alternatives for any of the products listed on the board. Write their answers next to the corresponding hazardous product.

5. Explain that "simplicity is the key". Four or five safe products can usually take the place of many other hazardous household items.

6. Hand out the "Safer Alternatives For Hazardous Products" sheets to each students. Read through substitutes with the class. Ask: Can you think of additional substitutes for the categories mentioned? Are any of these surprising? Can these substitutes be purchased easily? Where? Are any of these substitutes used in you home already? Do you think your family would be willing to try an alternative? If "no", why not?

7. Tell the students that they are going to play a game called Toxic-Free Bingo. Pass out a grid and a handful of markers to each student.*

8. Draw a card (with the safer substitutes on them) from a hat. Read it aloud. Students should then look for the hazardous item on their grid that can be replaced with the clue (the safer substitute). Example: Card drawn is "baking soda". Students may place a marker on detergents, deodorizer or

scouring powder. Students may only choose one. They may refer to their information sheet on safer alternatives. The object is to get four in a row; vertically, horizontally, or diagonally. Four corners also wins.

After the game, students can switch cards and play again. Keep cards for future games.

*** Note to teachers:** You may want to complete a master set of grids for the class. Each square is filled in with a hazardous product from the "Safer Alternative . . ." sheet. No word(s) may be used more than once on a grid. You can also choose to let the students complete their own grids, following the same directions as above.

Adapted from ***TOXICS IN MY HOME? YOU BET!, 1984***

Toxic Free Bingo

SAFER ALTERNATIVES FOR HAZARDOUS HOUSEHOLD PRODUCTS

The following is list of safer substitutes for some hazardous household products. Generally, these substitutes can be bought in grocery stores.

Aerosol Spray

- Aerosols should not be used at all!
- Use non-aerosol, pump-type sprays

Ant Control

- Sprinkle cream of tartar in front of the ant's path. Ants will not cross over. Cream of tartar is a substance used in baking.
- Try red chili pepper, salt, dried mint or sage in the ant's path.
- Mix 1 tablespoon borax, 1 tablespoon sugar and 2 tablespoons of water to make a thick syrup. Soak cottonballs in the mixture and put the cottonballs on low lids or something flat. Put the lids in the middle of the ant colony.

Bug Spray

- Place screens on windows and doors.
- Brewers yeast tablets taken daily give the skin a scent that mosquitos seem to avoid.

Chemical Fertilizers

- Compost
- Mulch
- Dried coffee grounds, bone meal and wood ashes.

Copper Cleaner

- Pour vinegar and salt over copper and rub.

Deodorizers/Air Fresheners

- Simmer cinnamon and cloves.
- Set out a dish of hot vinegar.
- Burn scented candles.
- Baking soda is good for odors in the refrigerator, cat box, drains and ash trays.

Detergents (Laundry and Dishwashing)

- For dishes, use baking soda and liquid soap.
- For laundry, use borax, washing soda or liquid soap.

Drain Openers

- Pour *boiling* water down the drain. Do this every week for preventive maintenance.
- Use a plumber's helper (plunger) or a plumber's snake.

Flea repellant

- Feed pets brewer's yeast, vitamin B or garlic tablets (not a lot!)
- Use eucalyptus leaves and seeds around the pet's bed.

Furniture Polish

- Mix lemon juice and vegetable oil.
- Mix vegetable oil and white vinegar.

Glass and Window Cleaners

- Use cornstarch and water.
- Mix 1/2 cup vinegar and one quart warm water. Wipe with newspapers.
- Use lemon juice and dry with a soft cloth.

Oven Cleaners

- Mix 3 tablespoons of washing soda with one quart of warm water.
- Place liners in oven to catch any drips during baking.
- Sprinkle salt on spills when they are warm and then scrub.
- Rub spills gently with steel wool.

Oil or Solvent Based Paint

- Use water based paints instead. They are less toxic than oil or solvent based. After using them, no solvent is necessary for "clean-up".

Rat and Mouse Poison

- Use mechanical-snap mouse traps.

Rug and Upholstery Cleaners

- For spills, clean with club soda and clean cloth.

Scouring Powders (Abrasive Cleaners)

- Use baking soda or borax with a damp cloth.
- Scrub area with 1/2 lemon dipped in borax.

Snail/Slug Bait

- Place a shallow pan with beer in the infested area.
- Overturn claypots. The snails will take shelter in them during the sunny days and they can be collected and removed.

MASTER CARDS

Cut each rectangle and place in a container. The item in parentheses is typically potentially hazardous. The item above it is a recommended safer alternative. The instructor reads the safer substitute.

lemon juice & vegetable oil
(furniture polish)

pump-type sprayers
(aerosol sprays)

hot vinegar set in dish
(deodorizer/air freshener)

baking soda & liquid soap
(detergent)

eucalyptus leaves
(flea repellent)

simmer cinnamon & cloves
(deodorizer/air freshener)

washing soda
(oven cleaner, detergents)

borax and 1/2 lemon
(scouring powders)

garlic tablets
(flea repellent)

cornstarch and water
(glass & window cleaners)

coffee grounds/bone meal/wood ashes
(chemical fertilizers)

pan with beer
(snail/slug bait)

boiling water
(drain opener)

plumber's snake
(drain opener)

water based paint
(oil/solvent based paint)

compost
(chemical fertilizers)

screens
(bug spray)

cream of tartar
(ant control)

brewers yeast
(bug spray & flea repellent)

salt on spills
(oven cleaners)

vinegar and salt
(copper cleaner)

club soda
(rug and upholstery cleaners)

SAFE SUBSTITUTE CARD GAME

Goal:
Students will identify and match safer substitutes to hazardous household substances.

School Subject:
Social Studies, Home Economics

Grades:
7th - 12th

Time:
One class period

Materials:
- One set of playing cards for every three or four students

PROCEDURE

1. Divide class into groups of three or four students each.

2. The object of the game is to make pairs of cards by matching a Hazardous Household Product card (marked HHP) with a corresponding Safer Substitute card (marked SS). Students may refer to their list of Safer Substitutes.

3. The rules:

Have a "dealer" pass out four cards to each player and to him/herself. The remaining cards are placed face down on the table as the "draw" stack.

The player to the left of the dealer begins by trying to form one or two pairs of cards from what is in his/her hand.

If a pair can be made, the player lays it face up on the table in from of him/her. The player then draws cards from the "draw" stack to replace the cards they have put down.

If a pair cannot be made, the player discards one card (forming a discard pile) and draws a new card. The next player to the left continues the game.

When there are no more cards in the "draw" stack, shuffle the discard pile and use as the "draw" stack.

When the instructor calls time, the player with the most matches wins. All pairs should be checked for accuracy.

4. After the game, ask: Why would it be good for a family to eliminate or reduce the use of hazardous products in the home? Does this seem like a difficult task to you? Why or why not?

Adapted from ***Toxics in My Home? You Bet!, 1984***

PLAYING CARDS (Cards Must Be Cut)

HHP RUG CLEANER HHP	HHP NO PEST STRIPS HHP	HHP CHEMICAL DRAIN OPENER HHP	HHP LINOLEUM FLOOR CLEANER/ WAX HHP	HHP RAT POISON HHP	HHP FLEA REPELLANT HHP
HHP SCOURING POWDER HHP	HHP AEROSOL ROOM DEODORIZER HHP	HHP CHEMICAL DRAIN OPENER HHP	HHP BATHROOM CLEANERS HHP	HHP BUG SPRAY HHP	HHP OIL BASED PAINTS HHP

PLAYING CARDS (Cards Must Be Cut)

HHP AEROSOL SPRAYS HHP	HHP SNAIL BAIT HHP	HHP CHEMICAL FERTILIZER HHP	HHP ANT POISON HHP	HHP SNAIL/BUG BAIT HHP	HHP DISHWASHING DETERGENT HHP
HHP GENERAL CLEANER AND DISINFECTANT HHP	HHP LAUNDRY DETERGENT HHP	HHP WINDOW CLEANER HHP	HHP AEROSOL ROOM DEODORIZER HHP	HHP FURNITURE POLISH HHP	HHP ALL PURPOSE CLEANER HHP

PLAYING CARDS (Cards Must Be Cut)

HHP SCOURING POWDER HHP	HHP DEODORIZER HHP	HHP OVEN CLEANER HHP	SS STEEL WOOL SS	SS VINEGAR SS	SS WASHING SODA SS
SS CLUB SODA SS	SS BREWERS YEAST SS	SS CORNSTARCH SS	SS LEMON JUICE SS	SS VEGETABLE OIL SS	SS SOAP AND WATER SS

PLAYING CARDS (Cards Must Be Cut)

SS EUCALYPTUS LEAVES SS	SS PUMP-TYPE SPRAYS SS	SS FRESH CUT FLOWERS SS	SS PAN WITH BEER SS	SS PLUNGER SS	SS OVERTURN CLAY POTS SS
SS BAKING SODA SS	SS WIDE OPEN WINDOWS FOR FRESH AIR SS	SS DRIED FLOWER PETALS MIXED WITH SPICES SS	SS MAYONNAISE AND SOFT CLOTH SS	SS PLUMBER'S SNAKE SS	SS BIO-DEGRADABLE SOAP SS

PLAYING CARDS (Cards Must Be Cut)

SS
WATER SOLUBLE PAINT
SS

SS
SCREENS OVER DRAIN PIPES
SS

SS
CREAM OF TARTAR
SS

SS
PESTICIDE (TOMATO HORNWORM)
SS

SS
COMPOST
SS

SS
SCREENS ON DOORS AND WINDOWS
SS

SS
MECHANICAL MOUSE TRAPS
SS

SS
DIPEL
SS

SELLING A SAFER ALTERNATIVE

PROCEDURE

Before beginning the activity, have the students study television commercials and magazine ads for product marketing, and to look for any environmental emphasis. Give them a few days to accomplish this, and have a class discussion on their findings.

Day One

1. Tell students that they are going to test a nonhazardous alternative to a product. After testing the alternative, they will then invent an advertisement that will persuade people to use the product.

2. Divide the class into groups of four. If testing the glass cleaner, help each group mix about 1 tablespoon of white vinegar in one quart of water. Have students wet the glass with a sponge and use a squeegee to dry it. If testing other nonhazardous alternatives, help students set up and test the alternative.

3. After trying the alternative, ask students, "How well did the alternative work? What are the pluses and minuses of using the alternative? What might be the 'selling points' for the alternative?"

Day Two

4. Challenge each group of four students to invent an advertisement that would persuade people to use the alternative. Have the students emphasize how their product is safer for humans and the environment. Groups may want to develop a television advertisement that they act out and/or videotape, or a magazine ad that they draw. In developing their ads, students must obey the following rule: you may state some facts and ignore others, but you may not say anything that is untrue.

Goals:
Students will:
- conduct an experiment to test how well a nonhazardous alternative to a hazardous product works
- create advertisements designed to sell the alternative
- describe selling tactics they used in their advertisements

School Subject:
Science, Language Arts, Visual and Performing Arts

Grades:
4th - 12th

Materials:
- For glass cleaner of vinegar and water:
  one tablespoon white vinegar
  one quart of water
  one container for mixing the solution
  one sponge and one squeegee for each group of four students
- Materials needed to test any other nonhazardous cleaning alternative (See Toxic Free Bingo activity for safer substitutes
- Drawing paper and colored pens or crayons

5. Have each group present its advertisement to the entire class. Afterward, help students talk about how well the advertisements worked and what tactics were used to persuade potential customers.

Adapted from ***TOXICS: TAKING CHARGE, 1989 and A-WAY WITH WASTE, 1985.***

HAZARDOUS SUBSTANCES IN MY HOME?

BACKGROUND

In the past, hazardous substances have been characterized and labelled in a variety of ways. If a chemical is considered a hazardous substance, by definition of the law, the product is subject to labeling requirements. But there are many inconsistencies in the labeling of household products. Reading labels is a good habit to form, despite these labeling inconsistencies.

PROCEDURE

Day One

1. List the Discussion/Test Questions on the board. Have students brainstorm answers to these questions.

2. Show the overhead "Hazardous Waste Characteristics". Discuss: What qualities makes something hazardous? (Harmful to human or animal health; harmful to the environment.) What is waste? (Something not needed anymore, or an unwanted by-product from the manufacture of an item.)

3. Show the overhead: "Hazardous Substances". Ask: What makes some substances more dangerous than others? (The amount required to cause harm.)

4. Divide the class into five groups. Give each group the chart on Hazardous Household Wastes. Using the chart, tell the groups to prepare a report for class presentation. Assign each group three products from the list generated in step 1.

Goals:
Students will:
- learn the basic characteristics that identify a substance as hazardous:
  1) ignitable
  2) corrosive
  3) reactive
  4) toxic
- identify commonly used household products that are hazardous to human and/or animal health and/or the environment if not used and disposed of properly

School Subject:
Science, Health, Home Economics

Grades:
6th - 9th

Time:
2 class periods

Materials:
For the teacher:
- overheads: "Hazardous Substances", "Hazardous Substance Characteristics", and "Hazardous Substance Toxicity Chart" (See pages 238, 239, 240)
- Examples of hazardous household substances: polishes, cleaners, pesticides, etc. Be sure that the container is empty, with the lid taped shut.

For the students:
- "Inventory of Potentially Hazardous Household Products" handout
- Tally sheet
- Hazardous Household Products chart

Each report should cover:

- the hazardous characteristics
- the type of product (automotive, household, etc.)
- the proper disposal choice (recycle, use up, etc.)
- a safer substitute

Have each group give their report.

5. Distribute the hazardous household waste survey. Tell students they will use this form to find out what hazardous products they might have in their homes and how these products are labelled to warn the consumer. This can be given as an overnight or longer assignment. Stress that these products are potentially hazardous and that caution should be taken while doing this inventory. Tell the students to ask their parents for assistance.

6. IMPORTANT: Discuss and make sure students understand the provisions of the warnings on the first page of the "Household Inventory and Disposal Survey". Using the example products that are brought to class, show how to fill out the inventory.

Day Two

1. Discuss some or all of the following questions after the students have completed and turned in their surveys. A tally sheet can be prepared that combines the results.

a) Which items were found most frequently?

b) Where were most of the products found? What are the best places to store potentially hazardous products? Did you find any products being stored unsafely?

c) What was the most common warning on the labels? Did similar products have similar warnings?

d) Which products had directions for safe disposal? Did any of the products mention the health effects that the product could have?

e) Were any products found that did not have adequate warnings, or that were unlabeled?

DISCUSSION/TEST QUESTIONS

1. Name two potentially hazardous products that could be found in each of the following areas of your home.

- bathroom (toilet bowl cleaner, certain house hold cleansers, soaps)
- kitchen (furniture polish, oven cleaner)
- garage/basement (pesticides, flea powders, paints)

2. Name four characteristics that identify a material as hazardous. What are the hazards that these products have? Can a product have more than one hazard?

3. What are three "warning" words (they describe toxicity levels) for hazardous substances?

Adapted from **A-WAY WITH WASTE, 1990**

Name ______________________________ Date ________ Period __________

Inventory of Potentially Hazardous Household Products

This activity is an inventory. You are going to hunt around your house, basement, and garage to find out which of these products you have. Ask your parents to assist you with this acivity.

Caution: Do not disturb or spill these products. Some of them might be harmful. Wash your hands carefully after you handle any container that might be leaking. (Not all household products are hazardous.)

1. Check off items you find. Add others that you find that are not on the list.
2. Write down the quantities you find. Write down how many containers and the size of the containers (12 oz, 1 pint, etc.)
3. Write down where you find the product (under sink, in kitchen, etc.) Use both the room and exact location.
4. Read the labels of the products. Write down any warnings (hazards and characteristics) that are on the labels.

Do you have?	How Much?	Where is it stored?	Warning Labels	Hazard Characteristics	Alternative (Do In Class)
HOUSE					
___Oven cleaner					
___Drain cleaner					
___Toilet cleaner					
___Disinfectants					
___Rug or upholstery cleaners					
___Floor or furniture polish					
___Bleach or cleaners with bleach					
___Photographic chemicals					

Do you have?	How Much?	Where is it stored?	Warning Labels	Hazard Characteristics	Alternative (Do In Class)
HOUSE (cont'd)					
___ Silver polish					
___ Pool chemicals					
___ Mothballs					
___ Powder or Abrasive cleaners					
___ Ammonia or cleaners with ammonia					
___ Spot removers					
PAINTS					
___ Enamel or oil base paints					
___ Latex or water base paints					
___ Rust paint					
___ Thinners and turpentine					
___ Furniture strippers					
___ Stain or finish					
AUTO					
___ Antifreeze					
___ Used oil					
___ Brake Fluid					
___ Transmission fluid					
___ Batteries					

Do you have?	How Much?	Where is it stored?	Warnings	Hazard Characteristics	Alternative (Do In Class)
AUTO (cont'd)					
___Gasoline					
PESTCIDES					
___Herbicides (weed killers)					
___Rat and mouse poison					
___Roach and ant killer					
___Flea collars and sprays					
___House plant insecticides					
___Fungicides					
___Slug bait					
___Other garden pesticides					
OTHER					

TALLY SHEET — HOUSEHOLD HAZARDOUS PRODUCTS

PRODUCT TYPE	WARNING LABEL			HAZARD CHARACTERISTIC				
	CAUTION	WARNING	DANGER	IGNITABLE	CORROSIVE	REACTIVE	TOXIC	OTHER
AUTOMOTIVE								
1.								
2.								
3.								
4.								
5.								
6.								
7. Others								
HOUSEHOLD								
1.								
2.								
3.								
4.								
5.								
6.								
7. Others								
PESTICIDES								
1.								
2.								
3.								
4.								
5.								
6.								
7. Others								

TALLY SHEET — HOUSEHOLD HAZARDOUS PRODUCTS

PRODUCT	WARNING LABEL			HAZARD CHARACTERISTIC				
TYPE	CAUTION	WARNING	DANGER	IGNITABLE	CORROSIVE	REACTIVE	TOXIC	OTHER
PAINTS								
1.								
2.								
3.								
4.								
5.								
6.								
7. Others								
OTHERS								
1.								
2.								
3.								
4.								
5.								
6.								
7. Others								
MISCELLANEOUS								

HAZARDOUS HOUSEHOLD PRODUCTS

Product	Hazardous Property	Non-Hazardous Alternative	Disposal
Household Cleaning Products			
Abrasive Cleaners and Scouring Powders	CORROSIVE TOXIC	Baking soda or borax on damp cloth or 1/2 lemon dipped in borax. Toothpaste for light stains. Never mix a cleaning powder containing chlorine with anything containing ammonia.	Household Collection Event or use all product.
Ammonia-based Cleaners	CORROSIVE TOXIC	Dilute white vinegar/water mixture or dissolved baking soda for bathrooms and general household use. Never mix ammonia-based cleaners with anything containing chlorine or bleach.	Household Collection Event or use all product. **Small** amounts may be diluted with water and poured down the drain (check with your local sewage treatment plant).
Bleach-based Cleaners and Chlorine Bleach	CORROSIVE TOXIC	Dry bleach, 1/2 cup white vinegar, baking soda, or borax for laundry or general household use.	Household Collection Event or use all product. **Small** amounts may be diluted with water and poured down the drain (check with your local sewage treatment plant). Never mix bleach or a product containing chlorine with anything containing ammonia.
Disinfectant Cleaners	CORROSIVE TOXIC	Borax/water or dilute rubbing alcohol/water mixture.	Household Collection Event or use all product. **Small** amounts may be diluted with water and poured down the drain (check with your local sewage treatment plant).
Drain Openers and Cleaners	CORROSIVE TOXIC	Pour boiling water down drains as a preventative measure. Unclog problem drains with plunger or metal snake.	Household Collection Event or use all product. Never mix drain openers with bleach or any other cleaners.
Glass and Window Cleaners	CORROSIVE TOXIC	Dilute white vinegar/water mixture and then wipe with newspapers or soft cloth with lemon juice. Never mix ammonia-based glass cleaners with anything containing chlorine.	Household Collection Event or use all product. **Small** amounts may be diluted with water and poured down the drain (check with your local sewage treatment plant).
Oven Cleaners	CORROSIVE TOXIC	Clean your oven as you use it. Use oven liners to catch drips. Use baking soda for scouring. Sprinkle salt on oven spill when warm and clean.	Household Collection Event or use all product.

Product	Hazardous Property	Non-Hazardous Alternative	Disposal
Rug and Upholstery Cleaners	CORROSIVE FLAMMABLE TOXIC	Cornmeal or cornstarch, cold water or club soda and a towel, or a soap-based non-aerosol rug shampoo.	Household Collection Event or use all product.
Spot Removers	FLAMMABLE TOXIC	Club soda, cold water, lemon juice, cornmeal/water paste, or use professional dry cleaning service.	Household Collection Event or use all product.
Toilet Bowl Cleaners	CORROSIVE TOXIC	Scrub with toilet brush using baking soda and liquid soap.	Household Collection Event or use all product.
Miscellaneous Household Products			
Aerosol Spray Can Products including air fresheners, hair spray, deodorants, etc.	FLAMMABLE	Use equivalent products that are not packaged in aerosol can form. For air freshening ventilate with outside air, set out hot vinegar in an open dish, scented candles, and/or baking soda boxes.	Household Collection Event or use all product.
Batteries	TOXIC	Rechargeable batteries, AC wall outlet power adapters, and solar-powered products.	Household Collection Event.
Drugs, Medicines, and Pharmaceuticals	TOXIC	Unknown.	Household Collection Event or **small** amounts may be diluted with water and poured down the drain (check with your local sewage treatment plant).
Floor and Furniture Polish	FLAMMABLE TOXIC	Dilute soapy water to clean and soft rag to shine. Mixture of vegetable oil with small amounts of lemon juice or white vinegar to polish.	Household Collection Event or use all product.
Mothballs	TOXIC	Cedar wood chips, dried lavender flowers, or newspapers will discourage moths.	Household Collection Event.
Nail Polish and Nail Polish Remover	TOXIC	Unknown.	Household Collection Event or use all product.
Shoe Polish	FLAMMABLE TOXIC	Use shoe polish that does not contain trichloroethylene (TCE), methylchloride, and/or nitrobenzene.	Household Collection Event or use all product.

Product	Hazardous Property	Non-Hazardous Alternative	Disposal
Silver and Copper Polish	FLAMMABLE TOXIC	Soak silver in 1 quart warm water/1 tsp. baking soda/1 tsp. salt mixture and a small piece of aluminum foil. Pour vinegar and salt over copper and rub.	Household Collection Event or use all product.
Pool and Hobby Products			
Artist and Model Paints	TOXIC	Unknown.	Household Collection Event or use all product or donate paint to local school or other group.
Firearm Ammunition	EXPLOSIVE	Unknown.	Household Collection Event .
Firearm-cleaning Solvents	FLAMMABLE TOXIC	Unknown.	Recycle.
Photographic Chemicals	CORROSIVE TOXIC	Unknown.	Household Collection Event or donate photo chemicals to local photo shop.
Pool Chemicals	CORROSIVE TOXIC	Unknown.	Household Collection Event or donate pool chemicals to local swimming pool owner.
Solvent-based glues	FLAMMABLE TOXIC	Use non-toxic glues where possible.	Household Collection Event or use all product.
Automotive Products			
Antifreeze	TOXIC	Unknown.	Recycle.
Auto Batteries	CORROSIVE TOXIC	Unknown.	Recycle or return old battery to auto parts shop when purchasing new battery.
Car Wax containing solvents	TOXIC	Unknown.	Household Collection Event or use all product.
Engine Cleaners and Degreasers	FLAMMABLE TOXIC	Unknown.	Recycle spent solvents. Non-recyclable wastes must be disposed of at Household Collection Event .
Gasoline and Diesel Fuel	FLAMMABLE TOXIC	Unknown.	Recycle.
Kerosene	FLAMMABLE TOXIC	Unknown.	Recycle.

Product	**Hazardous Property**	**Non-Hazardous Alternative**	**Disposal**
Motor Oil	FLAMMABLE TOXIC	Unknown.	Recycle.
Paints and Primers	FLAMMABLE TOXIC	Avoid auto paints packaged in aerosol spray cans. Take car to professional auto painters for extensive painting work.	Household Collection Event, use all product or donate to local auto paint shop.
Transmission Fluid	FLAMMABLE TOXIC	Unknown.	Recycle.

Pesticide and Garden Products

Chemical Fertilizers	TOXIC	Household compost, wood ashes, peat moss, fish meal, and/or manure are effective fertilizers that do not deplete the soil's growing capacity with extended use.	Household Collection Event or use all product.
Fungicides	TOXIC	Avoid over watering and keep garden growing areas clean and dry.	Household Collection Event.
Herbicides and Weedkillers	TOXIC	Pull or hoe weeds; keep grass short; and/or cover garden with opaque plastic to prevent weed germination.	Household Collection Event.
House Plant and Household Insecticides	TOXIC	Spray leaves of plants with mild soapy water and then rinse. Fix or install screens to keeps bugs out of the house or porch.	Household Collection Event.
Insecticides including Botanicals, Carbamates, Chlorinated Hydrocarbons, and Organophosphates	TOXIC	Apply organic gardening techniques; keep garden clean and weed free; remove plant debris and old wood; use mild insecticidal soap; and import predators (such as ladybugs, ground beetles, or praying mantis) that will feed on specific pests.	Household Collection Event.
Pet Products, Flea Collars, and Flea Sprays	TOXIC	Small amounts of brewer's yeast or vitamin B in the pet's diet, herbal baths, and/or eucalyptus leaves near pet's bed will discourage fleas and most parasites.	Household Collection Event or use all product.
Rat and Mouse Poisons and Arsenicals	TOXIC	Remove all sources of food; plug openings where rodents enter home with sheet metal or metal screen. Use humane live traps.	Household Collection Event.

Product	Hazardous Property	Non-Hazardous Alternative	Disposal
Roach and Ant Killers	TOXIC	Keep food areas clean; caulk or fill openings where insects enter home or hide; for roaches, carefully apply boric acid powder or dry baking soda/powdered sugar mixture where roaches hide; for ants, apply red chili powder or cream of tartar powder across path or at point of entry.	Household Collection Event.
Snail and Slug Poisons	TOXIC	Fill a shallow pan with inexpensive beer and set in infested area; overturn clan pots or lay boards between rows of planted vegetables and collect snails that attach themselves to the undersides of clay pots or boards.	Household Collection Event.
Paint Products			
Enamel or Oil-based Paints	FLAMMABLE TOXIC	Latex or water-based paints.	Household Collection Event, use all product or donate extra paint.
Furniture Strippers	FLAMMABLE TOXIC	Sandpaper, power sander, or heat gun.	Household Collection Event.
Latex or Water-based Paints	TOXIC	Limestone-based whitewash or cassein-based paint.	Donate extra paint. Air dry small amounts of latex paint outdoors in an open outdoor area; allow to harden completely and then dispose of in municipal garbage.
Paint Stripper	FLAMMABLE TOXIC	Sandpaper, power sander, heat gun, steel wool, and/or emery cloth, depending on type of surface to be stripped.	Household Collection Event.
Rust Paints	FLAMMABLE TOXIC	Unknown.	Household Collection Event, use all product or donate extra paint.
Stains and Varnishes	FLAMMABLE TOXIC	Latex paint or natural earth-pigment finishes.	Household Collection Event, use all product or donate extra product.

Product	Hazardous Property	Non-Hazardous Alternative	Disposal
Thinners, Solvents, and Turpentine	FLAMMABLE TOXIC	Hold used solvent or turpentine in a tightly closed jar until paint sludge settles out; pour off clear solvent and reuse. The use of latex and water-based paint doesn't require solvents or thinners other than plain water.	Most solvents can be recycled. Waste, including paint sludge with solvent, must go to Household Collection Event .
Wood Preservatives	FLAMMABLE TOXIC	Avoid products containing pentachlorophenol (PCP) or use water-based wood preservatives; minimize wood contact with soil or high moisture.	Household Collection Event .

CALIFORNIA DEPARTMENT OF HEALTH SERVICES, TOXIC SUBSTANCES CONTROL PROGRAM

HAZARDOUS SUBSTANCES AROUND SCHOOL

PROCEDURE

1. Select groups of students to research the different school buildings listed below for hazardous substances. These could include: janitor's office, chemistry or biology laboratories, home economics rooms, workshops, art rooms, office supplies rooms and also school pest control supply rooms. Note: the students are not to endanger themselves by handling the materials, this is for research only.

2. Distribute worksheets to the groups and have them fill the worksheets out with the help of the Hazardous Household Products chart.

3. Have the groups present their finds to the class and discuss alternatives to the hazardous substances.

Goals:
Students will realize that hazardous substances are around their school.

School Subject:
Science, Social Studies

Grades:
7th - 12th

Time:
2 - 3 class periods

Materials:
- Student worksheet
- Hazardous Household Products chart (See page 263)

Adapted from ***THE HAZARDOUS WASTE KIT, 1985.***

STUDENT WORKSHEET: Hazardous Substances At School

Category:

Item:

Hazardous Substance:

Direct or Indirect Hazard:

Exposure Route:

Toxicity:

Human Carcinogen:

STUDENT WORKSHEET: Hazardous Substances At School

Category:

Item:

Hazardous Substance:

Direct or Indirect Hazard:

Exposure Route:

Toxicity:

Human Carcinogen:

READ THE LABEL

BACKGROUND

Manufacturers of hazardous substances are required to have labels on their products to inform the consumer of the danger. There is not, however, a national standard for labelling hazardous consumer products. Thus products with identical hazardous substances could have different label information. Some products will give the full chemical name of a substance, while others may use a "trade name" or a "common name". (For example, wood alcohol is the common name for Methyl Alcohol or more precisely, Methanol.)

PROCEDURE

Day One

1. **Ask:** What does hazardous mean? What qualities would make something hazardous? What does the word "toxic" mean? (similar to poisonous; poisonous substances result in acute effects, toxic substances result in acute or chronic) Hold up a container of liquid drain opener or garden pesticide. **Ask:** Is this toxic? What's the safest way to find out? (read the label). What other household products might be toxic or hazardous? How does the label on a product give us information on potential hazards?

2. Show the overhead, "Hazardous Substance Characteristics". Using different hazardous household products as examples, identify the other characteristics of hazardous materials. (Corrosive, Reactive, Ignitable)

Circulate the household products (safely prepared) and ask students to discuss which hazardous properties each product has.

Goals:
Students will:
- understand that the same substances that make a product useful, can also make that product potentially hazardous
- understand that labels on household products contain important information on how to use, store and dispose of properly.

School Subject:
Science, Health, Social Studies, Home Economics

Grades:
7th - 10th

Time:
Two class periods and one homework assignment

Materials:
- Potentially hazardous household products such as drain opener, oven cleaner, scented furniture polish, aerosol air freshener, or pesticide.

Make sure the container is empty, but do not drain for the activity, and tape the lid shut.

- Student handouts:
  "What's in Your House", and "Read the Label" (two for each student)
- Overheads: "Hazardous Substances" "Hazardous Substance Characteristics", and "Hazardous Substance Toxicity Chart" (See pages 238, 239, 240)

Ask: Do any products have more than one kind of hazard? Are there any words on the label that you do not know the meaning of?

3. Tell students that many people are unaware that such common products may be hazardous. Consequently some products are often used or disposed of unsafely. However, the same substances that make a product a good cleaner or solvent by dissolving dirt, grease or other unwanted solids, can also act to dissolve your skin or the surface of your lungs, etc. Tell students that poisonings can occur not only by eating or drinking but also by breathing and skin absorption.

Tell students that direct or prolonged exposure to hazardous materials may damage human health in a variety of ways. Depending on individual sensitivity, a person may develop a headache, experience nausea or lightheadedness, or have difficulty breathing. Many other symptoms are also possible.

Some hazardous materials are associated with long term effects that may not be noticeable for years—for example cancer, birth defects or gene mutation. Chronic health effects are not usually on warning labels and are often unknown.

4. **Ask:** How does a product's label tell us that the product may be hazardous? What key words should we look for?

Show the overhead "Hazardous Substance Toxicity Chart". Tell students that these words not only apply to the degree of toxicity of the substance, but that they may also refer to how serious the consequences are of mishandling the product. Review the key words and help find ways of remembering the order of toxicity.

CAUTION: Use the product with care; low to moderate toxicity

WARNING: Means the product presents a greater hazard than "caution"; moderate to high toxicity

DANGER: Signals that exposure or unsafe use may cause injury, illness or death; high or extreme toxicity

5. Distribute copies of the handout "What's in Your House". Allowing about a half hour, have the students read and complete the worksheets. These worksheets deal with:
- drain openers/oven cleaners
- furniture polish
- air fresheners
- pesticides
- solvents

Discuss and review student responses.

6. Homework Assignment

Distribute two copies of the "Read the Label" worksheet to each student. Have students examine labels from at least two products with hazardous properties in their home. Tell students to fill out worksheets and prepare to participate in classroom discussion about their findings.

Day Two

Start the discussion with the following items:

1. Necessary precautions. What were some of the precautions that products had? Did the labels mention any health hazard from prolonged use?

2. Warning symbols. What, if any, warning symbols were used? Were the warning symbols clear?

3. First aid measures. What kind of first aid measures were printed on the labels? Were the instructions clear?

4. Ingredients. What are active ingredients? (The ingredients that make the product both useful and potentially harmful.) What are inert ingredients? (Substances that "carry" the active ingredient.) What are the amounts of the different kinds of ingredients? Why are some amounts larger than others? (Active ingredients are present in small amounts due to their potency.) Does the label list what the inert ingredients are? Why is it important to know the names of chemicals? (To be able to tell a doctor or other health professional the kind of poison, etc.)

5. Directions for use, storage, and disposal. What were some of the precautions listed in the direc-

tions for use? Did the label give any suggestions for storage? For disposal?

6. Divide the class into small groups and have them design and create labels for hazardous materials of their choice. To get them started, ask: What information should a hazardous product label list?

How should the information be displayed?

Adapted from ***A-WAY WITH WASTE, 1990, and TOXICS IN MY HOME? YOU BET!, 1984***

What's In Your House?

Solvents:

Are substances that dissolve other substances. The most familiar and universal of solvents is water. Water dissolves minerals and carries them in sap to the upper reaches of plants. In cooking, it dissolves sugar and salt. Nonwater-based solvents are called organic solvents, so called because chemicals like them (ie., those based on carbon) form the structure of living things. Most solvents are organic and capable of causing injury if not used properly.

Some solvents enter the body through skin contact because they dissolve oily materials (skin oils, for instance) so easily. Inhalation can have an irritant effect on mucous membrane and can cause nausea, headaches, muscular weakness, drowsiness, and impaired motor response (leading to a loss of coordination that contributes to increased accidents). One of the prime organ targets of solvents is the liver – the organ that removes poisonous chemicals from the body and aids in food digestion. The liver can be severely damaged by solvents that destroy liver cells. One symptom of liver disease is jaundice – a yellowing of the skin and eyes.

The eyes are a major target area of solvents. People who refuse to wear goggles place themselves at risk of injury when handling solvents.

Drain Openers:

Often contain a substance called sodium hydroxide. Another name for this is lye. It is very corrosive to body tissue and can cause burns. The degree of the burn depends on the amount of chemical exposure and the person's sensitivity to it. Drain openers are designed to eat away the materials clogging your drain. The material is generally made of organic matter—much like your skin. They should be used with extreme care. To avoid the release of toxic fumes, drain openers should never be mixed with another brand or with bleach. Most accidents involve children with burns of the mouth, face, esophagus, and upper digestive pathways.

What type of signal word and/or other precautions do you think should be listed on this product? Give your reasons.

LACQUER THINNER

Solvents can be splashed or reach the eyes by scratching an itch or pushing away some hair. This is especially dangerous if the victim is wearing soft contact lenses which can absorb the chemicals and hold them against the eyes until the lenses are removed. The length of exposure can cause considerable eye damage or irritation.

Solvents dry easily but the vapors still linger in the air and are breathed unless there is plenty of fresh air and good ventilation.

What type of signal word and/or other precautions do you think should be listed on this product? Give your reasons.

Furniture Polish:

May contain pretty scents and colors that are attractive to children who can be seriously injured by drinking them. Polishes come in different forms and different chemicals are used to help apply the polish onto the furniture.

NEW
Furniture
Polish
Million Dollar Shine!!

Some kerosene-like substances are present in some polishes. When ingested, they enter the lungs and saturate them so that the lungs cannot function. There is no way to rid the body of the poison or to reverse its effect.

The health dangers most often occurring with furniture polishes are from ingestion and inhalation of fumes – especially from the aerosols. The aerosol spray propellants may decompose to harmful gases when in contact with a heated surface.

Another common danger is the polish getting into sensitive parts of the body, especially the eyes.

Most polishes are flammable and can ignite when applied by someone who is smoking.

What type of signal word and/or other precautions do you think should be listed on this product? Give your reasons.

Air Freshener:

Usually act in one of three ways: (1) masking or counteracting one odor with another; (2) coating the nasal passages with an oily film; or (3) diminishing the sense of smell with a nerve-deadening agent. Tampering with our sense of smell can be dangerous because olfaction (smelling) is one of our best human defenses against fire, toxic gases, and decayed or spoiled foods.

Many air fresheners simpy contaminate the air with another foreign substance and have no freshening effect at all.

Some of the chemicals found in aerosol air fresheners can be extremely dangerous to internal tissues and organs.

Aerosols can become powerful bombs when exposed to heat, external pressure, or puncture. They are also a major source of air pollution in the home, particularly when used in small closed rooms such as the bathroom.

Nature's
Good
Scents
Air
Freshener

What type of signal word and/or other precautions do you think should be listed on this product? Give your reasons.

Pesticides:

Are poisons. Some of them remain in the environment for long periods of time and resist natural means of breakdown and decomposition. Some are formulated to rapidly breakdown. Some pesticides may destroy beneficial as well as harmful insects and can also harm plants, birds, fish, squirrels, and other wildlife. Chemical pesticides are a convenient way to get rid of or control unwanted insects or other pests, small mammals, weeds, or fungus growths. Convenience, however, comes at a high price. The price was realized by an 8 1/2 month old infant who had been suffering from a cough for a few weeks and then died five days after her room had been sprayed by an exterminator.

Pure n' Simple
PEST DEATH
PESTICIDE

In California alone, it is estimated that each year about 14,000 incidents of pesticide exposure result in requests for medical assistance. Most of these are nonoccupational exposures involving children in the home or garden.

Pesticides can injure the user if consumed, absorbed through the skin, or inhaled. Pesticide poisoning often resembles, and is mistaken for, the flu. Symptoms may include headaches, nausea, dizziness, aches, etc. Some pesticides have also been associated with more damaging effects such as cancer or birth defects.

Authorities believe that many pesticides (over 50 percent) have not been adequately tested for their ability to cause cancer or birth defects.

What type of signal word and/or other precautions do you think should be listed on this product? Give your reasons.

Oven Cleaners:

Most oven cleaners contain lye, much like drain openers. Some oven cleaners are in aerosol spray form. Aerosol sprays are particularly dangerous because the very fine mist spreads over a large area of the room and can land on skin, eyes, and sensitive lung tissue. While skin can regenerate itself, this is not true of the lungs. Seven regional poison centers across the country reported 620 exposures involving oven cleaners in 1983. This number is artifically low when you consider there are 26 regional centers and over a hundred smaller centers across the country. What type of signal words and/or other precautions do you think should be listed on these products? Give your reasons.

FOAMY
OVEN
CLEANER

Name ______________________________ **Class** ____________________

Product ______________________________

Read the Label Worksheet

Directions: Tell your parents about your assignment and ask for their assistance. Carefully read the label on the container and answer the following questions.

1. What is the name of the product?
2. What are its uses?
3. What are its active ingredients? Give their percentages, if any.
4. What are the product's inactive or inert ingredients? Give their percentages.
5. Does this product have any hazard or warning word or symbol? If so, what is it and what does it mean?
6. List any directions that help protect people's health.
7. Does this label offer any first aid directions? If so, what are they?
8. Briefly describe, from the label, directions for use and directions for storage.
9. Describe, from the label, directions for container disposal.
10. What other helpful information is listed on the label?
11. What information do you think should be on the label that is not there?
12. Would you buy and use this product again? Give reasons.
13. Does this product have any environmental warnings? If so, what are they? Could your disposal choice be a threat to the environment?

A HEALTHY RESPECT FOR HAZARDS

BACKGROUND

This activity emphasizes that hazardous product labels should be read and understood and if the products are used, they should be used properly.

PROCEDURE

1. Tell students that in this activity they will identify some of the chemicals commonly found in potentially hazardous household products. Explain that hazardous substances can have both long and short term adverse health effects. Say, "One way to avoid harmful health effects is to learn ways to reduce exposure to them."

2. Tell students that product labels, by using signal words such as *CAUTION, WARNING* and *DANGER*, can give us an idea of a product's potential hazard. However, it is often difficult to judge the level of hazard by looking at a list of product ingredients. Some potentially hazardous chemicals are called different names by different manufacturers. For example, the solvents toluene and toluol are the same chemical. Unless one is familiar with chemical names, it can be difficult to know what one is buying. Some products list hazardous ingredients that pose only immediate health risks. Chemicals associated with long term risks may not be listed at all or the long term health effects may not be known.

Tell students that they should limit their exposure to potentially hazardous household products. The best way to do this is to buy fewer of these products. Safer substitutes are available. In addition, people should take precautions when using these products.

Goals:
Students will:
- name some potential chemicals found in household products
- identify the threat to health posed by each of these chemicals

School Subject:
Science, Health, Home Economics

Grades:
9th - 12th

Time:
2 class periods

Materials:
- Student handouts:
  "Products and Precautions", "Reducing Exposure to Hazards in the Home", "Mini Dictionary on Toxic Substances", "Hazardous Substances Worksheet", "Sample Hazardous Household Products"

3. Distribute "Products and Precautions". Discuss the reasons for taking the precautions listed on the sheet, in particular:

- Avoid the use of aerosols whenever possible. (Fine aerosol mist may be breathed in and enter the blood stream. In addition, the aerosol propellants may contain chlorofluorocarbons (CFCs) which damage the earth's protective ozone layer.)

- Never mix products. Certain chemicals can react explosively with other chemicals. For example, ammonia and chlorine bleaches can produce a hazardous reaction. Other combinations of products can act synergistically, such that the harmful effects of each substance is enhanced in the presence of other chemicals. (It is also possible that harmful effects could be blocked by another chemical.)

- Reasons for other precautions are described in the information sheet, "Reducing Exposure to Hazards in the Home".

Ask: Can you think of other necessary precautions not listed here? (Example: Keep the number of the Poison Control Center near the telephone.)

4. Distribute the Mini Dictionary and the Hazardous Substances Worksheet. Tell students to use the Mini Dictionary to complete the Hazardous Substances Worksheet for the substances illustrated on the "Products and Precautions" sheet.

5. Duplicate the Worksheet on the board or use as a transparency. Record and discuss student answers. **Ask:** Do you have any of these products at home? If so, how often do you use them?

6. Homework Assignment

Distribute a blank "Hazardous Substances Worksheet" to each student. Tell students to find three potentially hazardous products in their home or on the shelf of a grocery or hardware store. Tell students to include at least one product with a substance that is not in the Mini Dictionary. Ask students to create, as best they can, an entry to the new substance to be included in the Mini Dictionary. As resources, students may use any ordinary dictionary or encyclopedia. (Teacher's note: most modern dictionaries give some information on a variety of chemicals, and some include information on hazardous characteristics.)

Have students use at least two different resources and record the sources of their information. Upper level students may want to use a chemical dictionary or text available at the library or learning resource center. Have students complete the "Hazardous Substances Worksheet" for the three products.

7. Next day in class: Have students bring the results of their "research" to class for discussion. Open the discussion by asking:

How difficult was it to find ingredient information for potentially hazardous products?

What sources did you use? Where were these sources? (at home, school, library, teacher, poison information center, etc.)

Did the sources of information conflict or have different kinds of information? (One source might tell the hazard characteristic, while another might describe why the product is used, etc.)

On the board, record and compare the students' descriptions of new substances for inclusions into the Mini Dictionary.

DISCUSSION/TEST QUESTIONS

What is the difference between long term and short term health effects of hazardous substances?

What does synergistic mean? (The action of two or more substances, organs, or organisms to achieve an effect of which each is individually incapable.)

Name three ways to get information about the health effects of hazardous substances.

Give four methods to reduce exposure to hazardous products.

Adapted from ***A-WAY WITH WASTE, 1990, and TOXICS IN MY HOME? YOU BET!, 1984***

PRODUCTS AND PRECAUTIONS

PRECAUTIONS (*HOW TO REDUCE EXPOSURE)*

- Use in well-ventilated area.
- Avoid use of aerosols whenever possible.
- Keep products out of reach of children and pets.
- Clean up after use.
- Wear protective clothing (e.g., long sleeve shirts, heavy shoes, long pants, gloves).
- Never mix products.
- Use only the recommended amount.
- Keep products in original containers.
- Buy only what you need.
- Others?

Foamy Oven Cleaner

LACQUER THINNER

Nail Polish Remover

NEW Furniture Polish

Nature's Good Scents

Timzoil MOTOR OIL

Beauty Bowl
TOILET BOWL CLEANER

Easy Pour FURNITURE POLISH

Pure n' Simple
PEST DEATH
PESTICIDE

HAIR SPRAY
For a powerful hold of hair!

REDUCING EXPOSURE TO HAZARDS IN THE HOME

USE PRODUCTS IN WELL-VENTILATED AREAS

Avoid breathing potentially harmful fumes. One open window is not considered adequate ventilation. If using a fan, make sure the air is blowing away from you, not in your face. Also, make sure the air is escaping to the outdoors and is not being recirculated indoors. Take "fresh air" breaks. Work outdoors.

AVOID USE OF AEROSOLS

Breathing the fine mist can cause it to settle deep in the lungs and be quickly absorbed in the bloodstream. Aerosols can explode when heated. They should never be placed in sunlight, near a stove, in a glove compartment or in a fire.

KEEP PRODUCTS OUT OF REACH OF CHILDREN AND PETS

Most poisonings occur when a product is left unattended. Keep all potentially hazardous products on high shelves, in locked cabinets, and away from food items to avoid any confusion or accidental contamination.

"CLEAN UP" WHEN YOU ARE FINISHED USING A POTENTIALLY HAZARDOUS HOUSEHOLD PRODUCT

Carefully seal products when you are through using them. Some open products can evaporate quickly, thus polluting the air. Store spray cans and other flammables in a cool place, away from heat sources. Rags used for polishing or stripping furniture are fire hazards. Keep them in a metal container to prevent oxygen from reaching the rags and igniting.

WEAR PROTECTIVE CLOTHING

Wear rubber gloves to prevent chemicals from entering the bloodstream by being absorbed through the skin. Protective glasses should be worn to keep particles and solutions out of the eyes. It is best not to wear soft contact lenses when working around solvents as they may absorb chemicals and keep them near the eye. Wear long sleeve shirts and pants and closed-toe shoes and socks to prevent skin contact.

NEVER MIX PRODUCTS

Some products contain hazardous chemicals that might be reactive and create intense heat and/or hazardous fumes when mixed with other products. For example, a toxic gas is created from mixing products containing chlorine bleach (e.g. cleaners) with ammonia or products containing acids (e.g. some toilet bowl cleaners). Never mix different brands of similar products. Each brand may contain different ingredients.

USE ONLY THE RECOMMENDED AMOUNT

Never use more of a product than the amount given on the label. Twice as much does not mean twice as effective and can cause more harm than good. For example, applying too much week killer (herbicide) to a garden can damage the soil and make it impossible to grow anything.

KEEP PRODUCTS IN THEIR ORIGINAL CONTAINERS

Over the years, some manufacturers have significantly altered the ingredients of a particular product. In the event of a poisoning, the product label can give a clue to the product's age and ingredients. If you do not intend to use a product immediately, it is a good idea to write the date of purchase on the product label. In addition, accidents have occurred because hazardous products were placed in containers associated with food and drink (e.g. cereal boxes, coffee cans, cider jugs, milk cartons). Kerosene and other petroleum products stored in soda bottles and tin cans have resulted in many accidental poisonings. Remember, many hazardous substances look like products that are safe to eat or drink.

BUY ONLY WHAT YOU NEED

Some products require using only small amounts to achieve effectiveness. Buying economy-size may leave you with unwanted portions and disposal problems.

Mini Dictionary

CHECK OUT SOME OF THE BIG WORDS ON MY BACK!
CLEANSER
MINI DICTIONARY

POTENTIAL HEALTH EFFECTS OF HAZARDOUS SUBSTANCES

A Mini Dictionary

From ***TOXICS IN MY HOME? YOU BET!***
Golden Empire Health Planning Center
Sacramento, CA

Some of the most common and frequently used household products contain hazardous chemicals. Unsafe use and disposal of these products can harm human health and the environment. The health effects listed in this dictionary include short term (acute), long term (chronic), and suspected effects. Little or nothing is known about the health effects of many chemicals. Also, very little is known about the reactive or synergistic effects of any chemicals (the effects produced when a chemical acts in combination with other chemicals). Sometimes the effects produced can be more toxic than the effects produced when the chemical acts alone.

It is important to realize that people react differently to different chemicals. Some people don't realize that their illness may be the result of exposure to chemicals in household products. For example, the headache or light-headedness you may feel several hours after cleaning the house may be the result of inhaling toxic fumes from inadequate ventilation or from the mixing of incompatible chemicals.

Most of the terms in this dictionary were actually taken from household product labels. Although there are requirements for Informing the consumer as to the potential danger and how to reduce this danger, often the information on the product label is confusing or lists chemical names that are unfamiliar to the general public. With a little practice, however, you can become skilled at identifying hazards in products used in the home.

Create your own Mini Dictionary entries here

Create your own Mini Dictionary entries here

Acephate Used in some insecticides. Moderately toxic by ingestion. A cholinesterase inhibitor.

Acetone Used as a solvent, paint, varnish and in manufacturing other chemicals. Flammable, dangerous fire risk. Moderately toxic by ingestion and inhalation. Exposure to high enough concentrations can cause dizziness, light-headedness and unconsciousness.

Ammonium Hydroxide Used as principal ingredient in many cleansers, such as stain removers, detergents and food additives. It is a strong base and therefore very caustic. Liquid and vapor extremely irritating, especially to eyes.

Cadmium Used in some batteries, as pigment in ceramic glazes and in baking enamels. Highly toxic when inhaled as a dust or aerosol and when ingested. Respiratory irritant. Carcinogen.

Carbaryl Used in insecticides. Suspected animal carcinogen. Also suspected of causing birth defects. May cause kidney damage. Toxic by ingestion, inhalation and skin absorption. Irritant. Cholinesterase inhibitor.

Carcinogen Any substance that causes the development of cancerous growths in living tissue.

Caustic Capable of corroding, burning, dissolving by chemical action.

Chlordane Was once widely used as an insecticide but currently used in underground application for termite control. Suspected carcinogen. Causes kidney damage. Affects the central nervous system, causing irritability, tremors, or convulsions. Toxic by inhalation, ingestion and skin absorption.

Chlorofluorocarbons Used to clean parts in some industries because of their solvent-cleaning properties, to expand polyurethane to make foam products, as refrigerants in air conditioners and refrigerators. Their use was prohibited in 1979 except for a few specialized items because of their depleting effect on the ozone layer. Human health effects are unknown.

Cholinesterase Inhibitor Used in insecticides. Are capable of producing poisoning and death in humans and animals by interfering with the mechanisms of nerve action.

Corrosive Any substance that burns, irritates or destructively attacks organic tissue or materials such as metals.

Dioxins Name used for more than 70 members of the family of chlorinated dioxins. Present as a contaminant in defoliants used in Vietnam (agent orange). Carcinogenic, teratogen and mutagen. Human toxicity is under continuing investigation. Has been banned by FDA for most purposes.

Isopropyl Alcohol Found in home products such as rubbing alcohol, lotions and hair products. Flammable, dangerous fire risk. Toxic by ingestion, inhalation and skin absorption.

Methylene Chloride Volatile liquid used as paint remover, degreasing solvent and as a aerosol propellant. Suspected carcinogen. Causes liver and kidney damage in animals. May produce central nervous depression.

Nitrosamines Potent cancer causing agent in animals. Can cause liver damage, jaundice and fever.

Pentachlorophenol Used as a fungicide, wood preservative, molluscicide. Toxic by ingestion, inhalation, and skin absorption. Abuse may be fatal. Solids and concentrated solutions may also produce skin irritation and even skin burn. In the eyes causes inflammation which may progress to permanent corneal injury. It is illegal to sell to other than licensed applicators.

Petroleum Distillate That portion of a liquid which is removed as a vapor and condensed during the petroleum distillation process.

Phosphoric Acid Used In making metal products, roof-proofing, fertilizer and in some detergents. Breathing the vapor can irritate the nose, throat and lungs. Toxic by ingestion, inhalation, irritant to skin.

Potassium Nitrate Used in chemical analysis, as a food additive, in medications and fertilizers. Contact with skin can cause burns. High levels can interfere with the ability of the blood to carry oxygen.

Potassium Hydroxide (Lye) A corrosive poison commonly used as cleaning agents. (See sodium hydroxide)

Potent Powerful. Having a strong effect.

Sodium Hydroxide (Lye) A strong corrosive poison. Commonly used as cleaning agents. Are present In many washing powders some denture cleaners, detergents, drainpipe cleaners and paint removers. Corrosive to tissue In presence of moisture, strong irritant to tissue, also toxic by ingestion.

Sodium Silicate Used in some detergents. Can cause irritation of skin, cornea and mucous membranes.

Teratogen A substance that causes growth abnormalities in embryos.

Toluene Used in industrial solvents, aviation gasoline, perfumes, medicines and explosives. Flammable, dangerous fire risk. Toxic by ingestion, inhalation and skin absorption. Possible reproductive hazard.

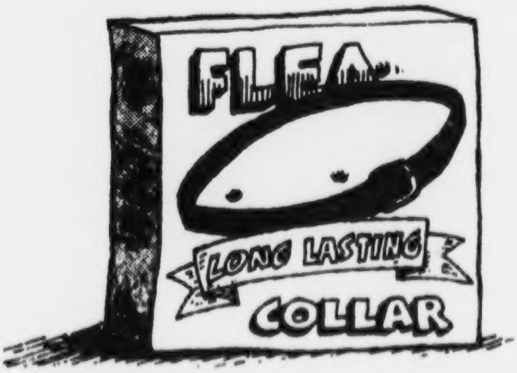
Ventilate To circulate fresh air.

Hazardous Substances Worksheet

Directions: Pick three products from the sample household hazardous products handout. Using the Mini-Dictionary, look up the health effects for the chemicals found in the products you choose. An example is given below. It is not necessary to list **all** the health effects given in the Mini-Dictionary. Under the column marked "How to Reduce Exposure", list two appropriate ways of reducing exposure to the chemical. The Products and Precautions Information sheet can assist you.

Product	Toxic Substance	Health Effects	How to Reduce Exposure
Example: Paint Remover	Toluene	Possible Reproductive Hazard	1. Avoid breathing the fumes 2. Wear protective clothing

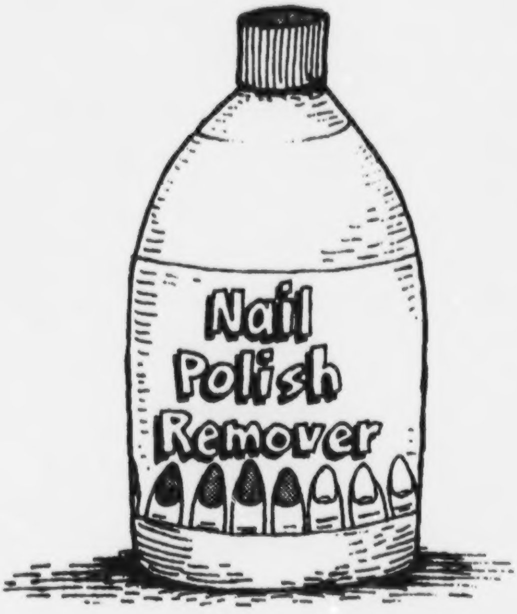
SAMPLE HAZARDOUS HOUSEHOLD PRODUCTS

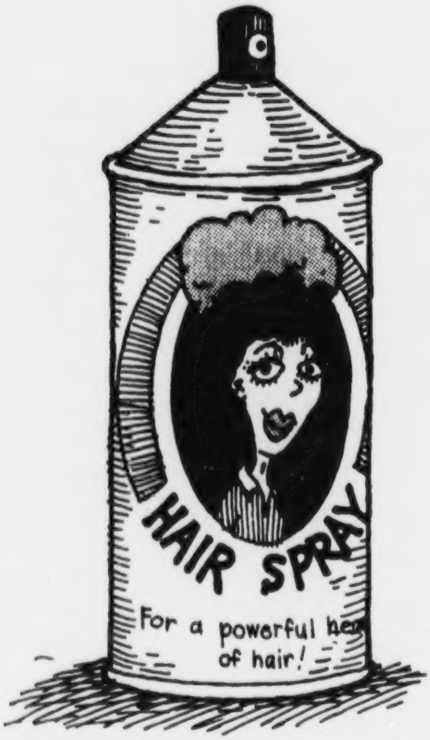


Warning: Dust will form on collar during storage. Do not get dust in mouth or eyes. Harmful if swallowed. If in eyes will cause eye irritation. In case of contact, flush eyes with water. If irritation persists, get medical attention. Note to doctor/vet: Dust released by this collar is a cholinesterase inhibitor. Atropine is antidotal.

Active ingredient: o-Isopropoxyphenyl methylcarbomate (9%)

Caution: Flammable, keep from heat or flame. Keep away from small children. Harmful if taken internally. In case of accidental ingestion, give fluids liberally and consult with local poison control center.

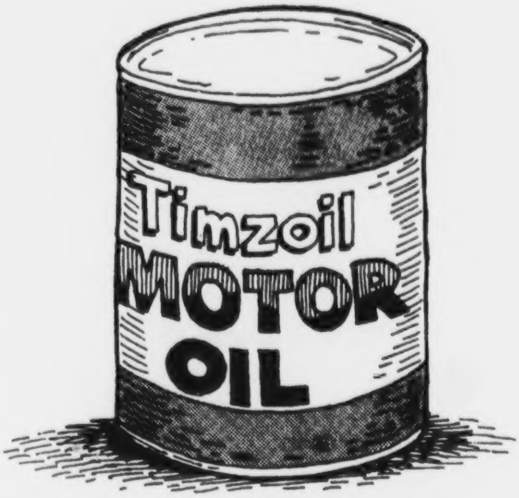


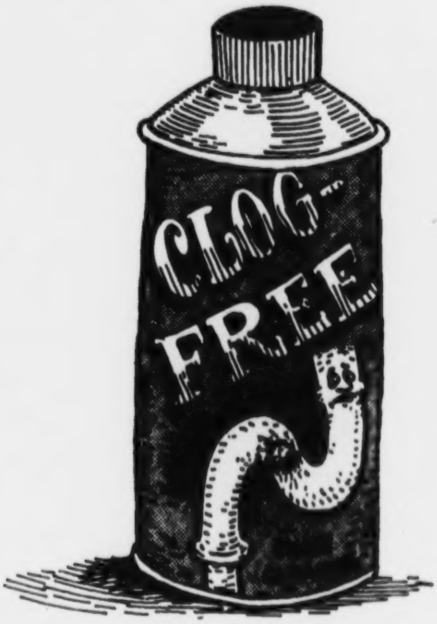


Warning: Avoid spraying in eyes. Contents under pressure. Do not puncture or incinerate. Do not store at temperatures above 120 degrees F. Keep out of reach of children. Use only as directed. Intentional misuse by deliberately concentrating and inhaling the contents can be harmful or fatal.

Flammable - Do not spray near open flame or while smoking.

Warning: Avoid skin contact with used motor oils. Used gasoline motor oils have caused skin cancer in laboratory animals when repeatedly applied and left in place between applications. In case of skin contact, promptly wash thoroughly with soap and water. Oil soiled clothing should be cleaned before reuse.





Poison: May be fatal or cause permanent damage if swallowed. Causes severe burns to eyes and skin. Contains sodium hydroxide (caustic soda-lye). May cause blindness. Avoid contact with skin, eyes, mouth and clothing.

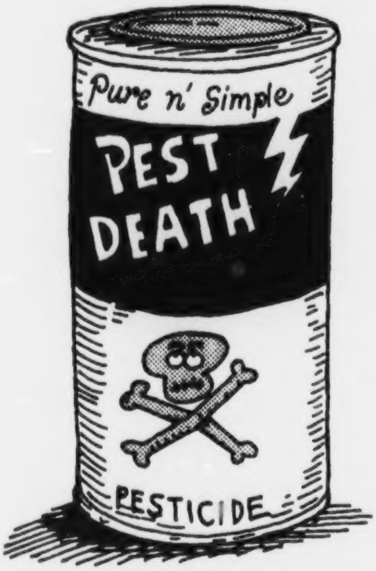
Always **keep out of reach of children.**

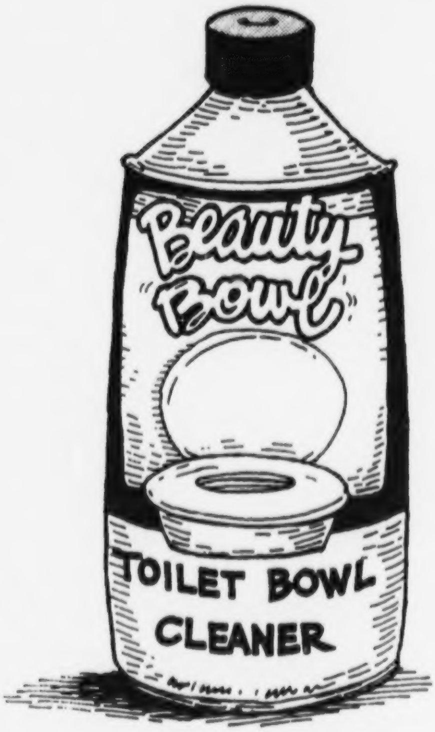
Hazards to Human and Domestic Animals: WARNING: KEEP OUT OF REACH OF CHILDREN. May be absorbed through skin. Do not breathe dust. Do not get in eyes, on skin or on clothing. Wear rubber gloves when handling. Keep children and pets away from treated area.

Statement of Practical Treatment: If swallowed give a large amount of water to drink, make person vomit and call a doctor. **Note to Physicians:** This product contains a cholinesterase inhibitor. Atropine is antidotal.

Environmental Hazards: This product is toxic to fish and wildlife. Birds feeding in treated area may be killed.

Active ingredients:
phosphorodithioate 1%
Inert ingredients 99%





Danger: Damaging to eyes. Harmful if swallowed. May be irritating to skin. Corrosive. Do not get in eyes, on skin or clothing. Do not take internally. Avoid contamination of food.

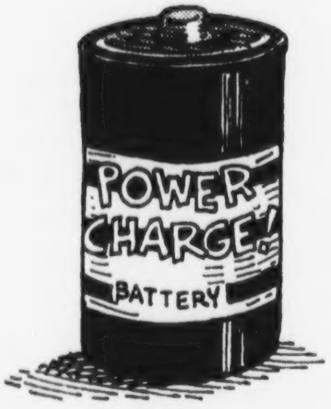
Physical and Chemical Hazards: **Never use with chlorine products**...can react to give cholorine gas. Never mix with other cleaners or chemicals.

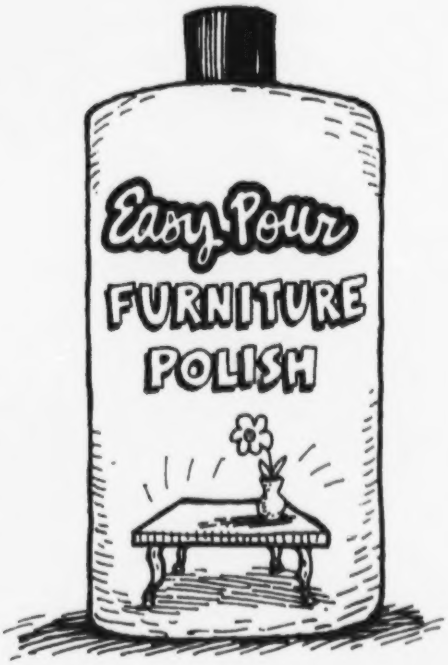
First Aid

Immediately - Eyes: Rinse immediately with water. Quickly remove contact lenses. Then flush eyes with water for 15 minutes.

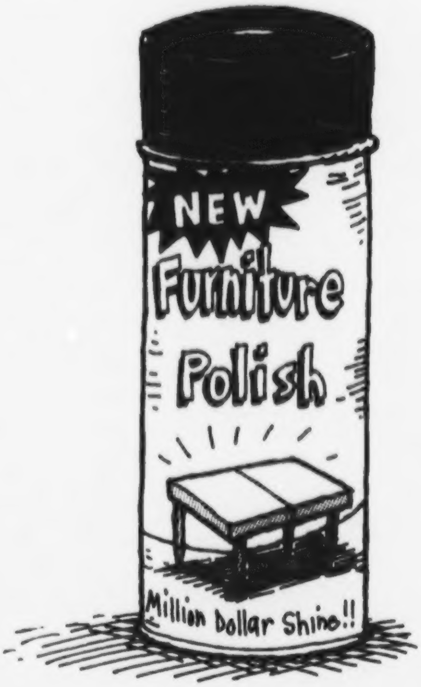
If swallowed: Rinse mouth. Drink a glass full of milk or water. **Do not** induce vomiting. Then call poison control or physician at once.

Caution: May explode or leak and cause burn injury if recharged, disposed of in fire, mixed with a different battery type, or inserted incorrectly.




Easy Pour
FURNITURE
POLISH

Danger: Extremely flammable. Harmful or fatal if swallowed. Combustible. Keep out of reach of children. Contains petroleum distillates. If swallowed, **do not** induce vomiting. **Call a physician immediately.** Do not use or store near flame.


NEW
Furniture
Polish
Million Dollar Shine!!

Caution: Do not use near fire or flame. Do not set or store container where temperatures exceed 120 degrees F., as container may burst. Do not puncture or incinerate. Do not spray or use on floors. Keep out of reach of children.

Contains no fluorocarbons.

From: ***A-WAY WITH WASTE, 1990***

1 + 1 = ?

PROCEDURE

1. In beakers, prepare the following solutions:

- Beaker 1: 50 ml white vinegar
- Beaker 2: 50 ml of baking soda solution

2. Present the following hypothetical situation: Suppose Beaker 1 contains the waste effluent of Ace Processing Plant. Beaker 2 contains the by-product effluent of Acme Manufacturing Company. Both wastes may be harmless by themselves. What might happen when they are dumped into the same waste water or waste disposal system?

3. Pour both beakers into Beaker 3. (The two substances should produce a frothing reaction.) Explain to students the principle of synergism, one aspect of which is that chemicals or compounds harmless in themselves can become toxic when combined in a landfill or waste water system.

4. There are many chemicals in manufacturing processes which can react synergistically when combined. You can also find chemicals in your household that when combined, react to produce a substance which is more harmful than the sum of the individual product effects.

Explain to students that testing for the harmful effects of chemicals used in our everyday life are done on the individual chemicals and most often are not tested for their combined or synergistic effects. Therefore, little is known about the combined effects of most chemicals.

Goals:
Students will:
- learn that combining certain household products increases the hazard that each might have alone
- understand the concept of synergism (a combination of interactions or substances that produce a total effect greater than the sum of the individual interactions or substances)

School Subject:
Science, Chemistry

Grades:
9th - 12th

Time:
30 minutes

Materials:
- Three breakers
- White vinegar
- Baking soda solution

5. **Ask:** How can we prevent these synergistic chemical reactions from occurring in waste water systems and landfills?

6. Which household products might cause this kind of problem if improperly used or disposed of? (Poisonous gases result when chlorine bleach is combined with ammonia and acidic products such as some drain, toilet bowl and metal cleaners.)

Adapted from ***A-WAY WITH WASTE, 1990***

A HAZARDOUS DEBATE

PROCEDURE

1. Distribute the issue cards to the class and allow them fifteen minutes to choose one side of one issue to debate.

2. Group the students by issue, one or two students per side (all issues need not be used).

3. Instruct the issue groups to write down why they chose their particular side to the issue and what additional information, if any, that they would need to support their side.

4. Have the issue groups present their comments to the class.

5. To extend this activity, have students follow up on obtaining information to support their positions and hold a debate the following day.

Goals:
Students address issues of health and safety about hazardous waste.

School Subjects:
Social Studies, Health

Grades:
9th - 12th

Time:
1 - 2 class periods

Materials:
- Copies of issue cards

Adapted from ***TOXICS IN MY HOME? YOU BET!, 1984***

ISSUE AREA 1

Side A

Health and safety data on any chemical should be available to any member of the public.

Side B

Manufacturers should be allowed to keep health and safety data secret.

ISSUE AREA 2

Side A

Chemical companies should pay for health and safety tests of their chemicals.

Side B

Health and safety tests should be financed by public funds.

ISSUE AREA 3

Side A

States or communities should be able to set disposal standards that are stricter than those set by the federal government.

Side B

States or communities should not be able to set standards that are stricter than those set by the federal government.

ISSUE AREA 4

Side A

We should try to limit our consumption of synthetic products (nylon and plastic, for example) that tend to generate hazardous wastes during their manufacture.

Side B

We should take full advantage of the benefits of modern technology and enjoy all products, hoping that a safe means for disposal of all hazardous wastes will be developed at some point.

ISSUE AREA 5

Side A

We should ship our hazardous waste to other countries if they are willing to receive it.

Side B

We should not ship our hazardous waste to other countries in lieu of finding safe technology for its disposal.

ISSUE AREA 6

Side A

The ocean is large and resilient, an ideal place for diluting hazardous waste, and should be used for dumping.

Side B

Ocean dumping of hazardous waste should not be used.

ISSUE AREA 7

Side A

The federal government should be able to determine where hazardous waste dumps should be located.

Side B

Local communities should be able to determine whether or not they want a hazardous waste disposal facility in their community.

ISSUE AREA 8

Side A

We should keep local people employed with jobs (such as maintaining roadside and public garden landscaping) rather than using dangerous pesticides.

Side B

Pesticides are convenient and very effective and should be used instead of alternative pest control measures.

ISSUE AREA 9

Side A

Household quantities of wastes are small enough that they should not be regulated like industrial wastes.

Side B

Household quantities of hazardous substances should be regulated the same as industrial quantities. The same chemicals used by households are used by industries who manufacture or use the product.

WASTE GLOSSARY

Benzene: a solvent widely used in chemical processes

Bioaccumulation: the process by which the biological concentration of a substance is increased through links in a food chain; another term for biological magnification

Biodegradable: a term describing a substance or material which can be broken down into simpler compounds by microorganisms

CERCLA: abbreviation for the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund Act), 1980. This provides funds for emergency cleanup of spills and cleanup of abandoned or inactive hazardous waste sites.

Chlorinated hydrocarbons: synthetic organic chemicals that contain hydrogen, carbon, and chlorine. Example: DDT and other insecticides

Composting: a waste management alternative in which organic wastes are partially decomposed by aerobic bacteria, producing a useful soil enricher

DDT: abbreviation for dichlorodiphenyltrichloroethane; a chlorinated hydrocarbon insecticide now banned from generalized use in the United States. A persistent in the environment.

Dump: a site where mixed wastes are indiscriminately deposited, without regard to the protection of the environment; also common usage for a landfill considered environmentally sound. Energy recovery: getting energy from solid wastes by any conversion process; for example, obtaining and using the heat produced by the burning of solid wastes

EPA: abbreviation for the Environmental Protection Agency, the Federal agency charged with the enforcement of all Federal regulations having to do with air and water pollution, radiation and pesticide hazard, ecological research, and solid waste disposal

Food chain: the sequences of organisms through which energy and materials progress (through the various trophic levels) from producers - green plants, to the highest consumers

Groundwater: water stored in porous spaces of underground soil and rock; more than half of the people of the United States depend upon groundwater for their drinking water

Hazardous materials: chemicals that pose a significant threat to human health and/or the environment

Hazardous substances: chemicals that are dangerous to human health and/or the environment

Hazardous waste: waste that is dangerous to human health and/ or environment; defined as being waste that is toxic, corrosive, reactive, or ignitable

Heavy metals: metallic elements (e.g., cadmium, lead, mercury) which are persistent in the environment, poisonous, and are subject to biological magnification

Herbicide: a chemical used to kill plants; a kind of pesticide

Ignitable: capable of burning rapidly; a flash point less that 140 degrees F

Incinerator: a facility designed for the controlled burning of waste; reduces waste volume by converting waste into gases and a relatively small amount of ash. May offer potential for energy recovery.

Landfill: a large, outdoor area for waste disposal. Landfills where waste is exposed to the atmosphere are called open dumps; in sanitary landfills, waste is layered and covered with soil

Leachate: the liquid forming when water (from precipitation) infiltrates through the soil covering a landfill and percolates down through the waste, picking up a variety of suspended and dissolved materials from the waste

WASTE GLOSSARY Cont.

Litter: highly visible solid waste that is generated by consumers and carelessly and improperly discarded (e.g., along roadsides or on streets and sidewalks)

Municipal waste: the combined residential, commercial, institutional, industrial, construction, and demolition waste materials generated in a given municipal area

NIMBY: acronym for Not In My Back Yard. Refers to the fact that people want the convenience of products and proper disposal of the waste generated by their use of the products, provided the disposal area is not located near them

Nonbiodegradable: not capable of being broken down by microorganisms

PCBs: abbreviation for polychlorinated biphenyls. A large class of synthetic chlorinated hydrocarbons widely used in the past by industry; persistent in the environment and subject to bioaccumulation. Suspected to be carcinogenic

Persistent: slowly or very slowly degradable in the environment; for example, glass, plastic, and many toxic substances

Pesticide: a chemical used to kill an organism (microbe, plant, insect or animal) considered to be a pest, i.e., one that causes loss, inconvenience, health hazard, etc.

Petrochemical: a chemical derived form petroleum or natural gas

Phenols: crystalline caustic poisonous acidic compounds present in coal tar and wood tar that are used in dilute solutions as disinfectants

RCRA: abbreviation for the Resource Conservation and Recovery Act, 1976. It requires states to develop solid waste management plans and prohibits open dumps. The RCRA also identifies lists of hazardous wastes and sets the standards for their disposal.

Recycle: to separate a given waste material from other wastes and to process it so that it can be used again in a form similar to its original use.

Reduction: the process of decreasing the amount of waste generated at each step of product development or use.

Reuse: to use something again for its original purpose, for instance, returning milk bottles for reuse.

Sanitary landfill: a land area where solid wastes are disposed of using a method that protects human health and the environment by spreading the waste in layers, compacting it to the smallest practical volume, and covering it with soil at the end of each day.

Solid waste: any of a wide variety of solid materials, as well as some contained liquids, which are discarded or rejected as being spoiled, useless, worthless, or in excess.

Solid waste management: everything that must be done to handle all the solid waste produced in a community, including the planning, collecting,transporting, and processing aspects of waste disposal.

Source separation: the separating of recyclable materials at the place of use before disposing of them.

Superfund: a term used for the fund established to implement the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Toxic: defined for regulatory purposes as containing poison and posing a substantial threat to human health and/or the environment.

Waste exchanging: using the waste from one activity as a resource in another activity.

Sources: **WASTE: A HIDDEN RESOURCE, 1989 and LIVING LIGHTLY ON THE PLANET, 1987**

APPENDIX A

LIST OF SOURCES

A-WAY WITH WASTE
Grades K-12; 3rd edition, 1990
Washington State Department of Ecology
4350 150th Ave. NE
Redmond, WA 98052
Contact: Jan Lingenfelter
(206) 867-7043

ADVENTURES ON THE AIR CYCLE
SONGS FOR THE EARTH
(audio tapes and songbooks)
The Banana Slug String Band
P.O. Box 717
Pescadero, CA 94060
Contact: (408) 429-9806

CALIFORNIA CLASS PROJECT, 1984
California State Department of Education
Orange County Superintendent of Schools
200 Kalmus Dr.
Costa Mesa, CA 92626

CALIFORNIA STATE ENVIRONMENTAL EDUCATION GUIDE, 1984, 1988
TOXICS: TAKING CHARGE, 1989
Alameda County Office of Education
313 West Winton Avenue
Hayward, CA 94544-1198
Contact: (415) 887-0152 extension 345

CLASS PROJECT
Grades 10-12
National Wildlife Federation
1412 16th Street., N.W.
Washington, D.C. 20036
Contact: (202) 797-6800

FOURTH R
San Francisco Recycling Program
Parkside Center, Rm. 13
2550 25th Avenue
San Francisco, CA 94116
Contact: Michele Roest
(415) 661-6479

GREAT (Groundwater Resources and Educational Activities for Teaching)
Grades 7 - 9, 1989
Iowa Department of Natural Resources
Contact: Conservation Education Center
R.R. 1, Box 53
Guthrie Center, IA 50115

THE HAZARDOUS WASTE KIT
The Federation of Ontario Naturalists
355 Lesmill Road
Don Mills, Ontario M3B2W8

HAZ MAN (Program Kits on Household Hazardous Waste)
San Bernardino County Department of
Environmental Health Services
385 N. Arrowhead Avenue
San Bernardino, CA 92415

HERE TODAY, HERE TOMORROW: REVISITED
Grades 4 - 8
Department of Environmental Protection
Division of Solid Waste Management
401 East State Street
Trenton, NJ 08625
Contact: (609) 292-0331

THE INCREDIBLE EDIBLE CHEMICAL LANDFILL
Rich Wagner
Hatboro, PA 19040

LIVING LIGHTLY IN THE CITY (GRADES K - 6)
LIVING LIGHTLY ON THE PLANET (GRADES 7 - 12)
National Audubon Society
613 Riversville Road
Greenwich, CT 08630
Contact: (203) 364-0520

SLEUTH
Metro Toxicant Program
Municipality of Metropolitan Seattle
available through:
Washington State Office of
Environmental Education
17011 Meridian Avenue N., Room 16
Seattle, WA 98133
Contact: Tony Angell
(206) 542-7671

TOXICS IN MY HOME? YOU BET!
Local Government Commission
909 12th Street
Sacramento, CA 95814
Contact: (916) 448-1198

TVA - A WORLD OF RESOURCES, GROUNDWATER - A VITAL RESOURCE, WASTE - A HIDDEN RESOURCE
Environmental Education Program
Tennessee Valley Authority
Forestry Building
Norris, TN 37828
Contact: (615) 632-1599

WATER, PRECIOUS WATER, BOOK A
AIMS Education Foundation
P.O. Box 7766
Fresno, CA 93474

APPENDIX B

ACTIVITIES LISTED ALPHABETICALLY

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Brown Air 63
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The Legacy of Love Canal 159
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APPENDIX C

ACTIVITIES LISTED BY SOURCE

A-WAY-WITH-WASTE

1 + 1 = ?

2001: A Trash Odyssey

A Careful Consumer's Trip to the Grocery Store

A Healthy Respect for Hazards

Be a Garbage Detective

Bikes and By-Products

Deciding What to Do

Extra Fancy Duds

Hazardous Substances In My Home?

Hazardous Waste Hot Potato

Hazardous Waste In My Home Town?

How Very Little It Must Be

Is My Business Your Business?

Logos and Slogans for Recycling

Model City Relay

More Than Meets the Eye

Natural Resources: Handle With Care

Necessary Wrappers?

Nonrenewable Resources: How Long Will They Last?

Nowhere Is Away

Nurture Some Nature

Oil and Water Don't Mix

Plastic Trash and Wildlife

Read the Label

Site Unseen?

Solid Waste: What's My Responsibility?

Something Old, New, Borrowed, Blue

Take a Bite of the Finite

Take-Home Recycling Kit

The Art of Solid Waste

The Throwaway Three

Trading Toxics

Waste, Then and Now

What Goes Around Comes Around

What Is Garbage to You May Be Gorgeous to Me

What's In a Cycle?

ADVENTURES ON THE AIR CYCLE, SONGS FOR THE EARTH

Brown Air

Where is Away?

CALIFORNIA ENVIRONMENTAL EDUCATION GUIDE

Ecological Picnic

Monitoring Particles In the Air

Needs and Wants

Oil Spill

The Consequences of Litter

Water Charades

CALIFORNIA DEPARMENT OF HEALTH SERVICES

Introducing the 3 R's

Making Recycled Paper

GREAT

Not Everything Made From Scratch Is the Best

Plastic Is a Problem

Risks and Benefits

The Problem With Landfills

Using Groundwater Models

LIVING LIGHTLY ON THE PLANET

Balance In an Aquatic Community

The Legacy of Love Canal

When the Gears Don't Mesh

SLEUTH

Solubility In Water

What Is Evaporation?

THE CLASS PROJECT

NIMBY

The Not So Gentle Rain

THE FOURTH R

Incineration

What Is Oil Really Like?

THE HAZARDOUS WASTE KIT

Hazardous Substances Around School

TOXICS IN MY HOME? YOU BET!

A Hazardous Debate

Poison That Looks Like Food

Safe Substitute Card Game

Safety the Housekeeper

The Big Three of Toxics

Toxic-Free Bingo

Word Puzzle

TOXICS: TAKING CHARGE

Finding Community Resources

How Do I Feel?

Selling a Safer Alternative

TVA: A WORLD OF RESOURCES

Sulfur Dioxide Dangers

Super Cycle

Characteristics In an Aquatic Community

WAGNER, RICH

Incredible Edible Chemical Landfill

WATER PRECIOUS WATER, BOOK A

Mini Water Treatment Simulation

APPENDIX D

ACTIVITIES LISTED BY AGE GROUP

KINDERGARTEN

Be a Garbage Detective

Extra Fancy Duds

Necessary Wrappers?

Poison That Looks Like Food

Something Old, New, Borrowed, Blue

Water Charades

What Is Garbage to You May Be Gorgeous to Me

Word Puzzle

GRADE ONE

Be a Garbage Detective

Extra Fancy Duds

Necessary Wrappers?

Poison That Looks Like Food

Something Old, New, Borrowed, Blue

Water Charades

What Is Garbage to You May Be Gorgeous to Me

Word Puzzle

GRADE TWO

Extra Fancy Duds

Necessary Wrappers?

Nurture Some Nature

Poison That Looks Like Food

Safety the Housekeeper

Something Old, New, Borrowed, Blue

Water Charades

What Is Garbage to You May Be Gorgeous to Me

What's In a Cycle?

Word Puzzle

GRADE THREE

Bikes and By-Products

Consequences of Litter

Ecological Picnic

Extra Fancy Duds

Incineration

Mini Water Treatment Simulation

Monitoring Particles In the Air

More Than Meets the Eye

Necessary Wrappers?

Needs and Wants

Nowhere Is Away

Nurture Some Nature

Oil Spill

Poison That Looks Like Food

Safety the Housekeeper

Something Old, New, Borrowed, Blue

Super Cycle

Take-Home Recycling Kit

Water Charades

What Is Garbage to You May Be Gorgeous to Me

What's In a Cycle?

Word Puzzle

GRADE FOUR

Bikes and By-Products

Consequences of Litter

Ecological Picnic

Extra Fancy Duds

Finding Community Resources

Hazardous Waste Hot Potato

How Do I Feel?

Incineration

Incredible Edible Chemical Landfill

Logos and Slogans for Recycling

Making Paper

Mini Water Treatment Simulation

Model City Relay

Monitoring Particles In the Air

More Than Meets the Eye

Necessary Wrappers?

Needs and Wants

Nowhere Is Away

Nurture Some Nature

Oil and Water Don't Mix

Oil Spill

Safety the Housekeeper

Selling a Safer Alternative

Something Old, New, Borrowed, Blue

Super Cycle

Take-Home Recycling Kit

The Art of Solid Waste

The Big Three of Toxics

The Throwaway Three

Toxic-Free Bingo

Water Charades

What Is Garbage to You May Be Gorgeous to Me

What Is Oil Really Like?

What's In a Cycle?

GRADE FIVE

Bikes and By-Products

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Extra Fancy Duds

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The Throwaway Three

Toxic-Free Bingo

Waste, Then and Now

Water Charades

What Is Garbage to You May Be Gorgeous to Me

What Is Oil Really Like?

What's In a Cycle?

GRADE SIX

A Careful Consumer's Trip to the Grocery Store

Bikes and By-Products

Consequences of Litter

Ecological Picnic

Finding Community Resources

Hazardous Substances In My Home?

Hazardous Waste Hot Potato

How Do I Feel?

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The Big Three of Toxics

The Not So Gentle Rain

The Throwaway Three

Toxic-Free Bingo

Waste, Then and Now

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GRADE SEVEN

A Careful Consumer's Trip to the Grocery Store

Balance In an Aquatic Community

Ecological Picnic

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Nonrenewable Resources: How Long Will They Last?
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Nowhere Is Away
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Oil Spill
Plastic Is a Problem
Plastic Trash and Wildlife
Read the Label
Safe Substitute Card Game
Selling a Safer Alternative
Site Unseen?
Solubility In Water
Take a Bite of the Finite
The Art of Solid Waste
The Not So Gentle Rain
The Problem With Landfills
Toxic-Free Bingo
Using Groundwater Models
Waste, Then and Now
What Goes Around Comes Around
What Is Evaporation?

GRADE EIGHT

A Careful Consumer's Trip to the Grocery Store
Balance In an Aquatic Community
Ecological Picnic
Hazardous Substances Around School
Hazardous Substances In My Home?
Hazardous Waste In My Home Town?
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Making Paper
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Nonrenewable Resources: How Long Will They Last?
Not Everything Made From Scratch Is the Best
Nowhere Is Away
Nurture Some Nature
Oil and Water Don't Mix
Oil Spill
Plastic Is a Problem
Plastic Trash and Wildlife
Read the Label
Safe Substitute Card Game
Selling a Safer Alternative
Site Unseen?
Solubility In Water
Take a Bite of the Finite
The Art of Solid Waste
The Not So Gentle Rain
The Problem With Landfills
Toxic-Free Bingo
Using Groundwater Models
Waste, Then and Now
What Goes Around Comes Around
What Is Evaporation?

GRADE NINE

1 + 1 = ?

2001: A Trash Odyssey

A Careful Consumer's Trip to the Grocery Store

A Hazardous Debate

A Healthy Respect for Hazards

Balance In an Aquatic Community

Characteristics In an Aquatic Community

Deciding What to Do

Ecological Picnic

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Hazardous Substances In My Home?

Hazardous Waste In My Home Town?

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Logos and Slogans for Recycling

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Nonrenewable Resources: How Long Will They Last?

Not Everything Made From Scratch Is the Best

Nurture Some Nature

Oil and Water Don't Mix

Oil Spill

Plastic Is a Problem

Plastic Trash and Wildlife

Read the Label

Risks and Benefits

Safe Substitute Card Game

Selling a Safer Alternative

Site Unseen?

Solid Waste: What's My Responsibility?

Solubility In Water

Sulfur Dioxide Dangers

Take a Bite of the Finite

The Art of Solid Waste

The Not So Gentle Rain

The Problem With Landfills

Trading Toxics

Using Groundwater Models

Waste, Then and Now

What Goes Around Comes Around

What Is Evaporation?

GRADE TEN

1 + 1 = ?

2001: A Trash Odyssey

A Careful Consumer's Trip to the Grocery Store

A Hazardous Debate

A Healthy Respect for Hazards

Balance In an Aquatic Community

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Hazardous Waste In My Home Town?

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NIMBY

Nonrenewable Resources: How Long Will They Last?

Not Everything Made From Scratch Is the Best

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Oil Spill

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Plastic Trash and Wildlife
Read the Label
Risks and Benefits
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Solid Waste: What's My Responsibility?
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Sulfur Dioxide Dangers
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The Art of Solid Waste
The Legacy of Love Canal
The Not So Gentle Rain
The Problem With Landfills
Trading Toxics
Using Groundwater Models
Waste, Then and Now
What Goes Around Comes Around
What Is Evaporation?
When the Gears Don't Mesh

GRADE ELEVEN

1 + 1 = ?
2001: A Trash Odyssey
A Careful Consumer's Trip to the Grocery Store
A Hazardous Debate
A Healthy Respect for Hazards
Balance In an Aquatic Community
Characteristics In an Aquatic Community
Deciding What to Do
Ecological Picnic
Hazardous Substances Around School
Hazardous Waste In My Home Town?
How Very Little It Must Be
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NIMBY
Nonrenewable Resources: How Long Will They Last?
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Nurture Some Nature
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Oil Spill
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Solid Waste: What's My Responsibility?
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Sulfur Dioxide Dangers
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The Legacy of Love Canal
The Not So Gentle Rain
The Problem With Landfills
Trading Toxics
Using Groundwater Models
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What Goes Around Comes Around
What Is Evaporation?
When the Gears Don't Mesh

GRADE TWELVE

1 + 1 = ?

2001: A Trash Odyssey

A Careful Consumer's Trip to the Grocery Store

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Characteristics In an Aquatic Community

Deciding What to Do

Ecological Picnic

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Natural Resources: Handle With Care

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Nonrenewable Resources: How Long Will They Last?

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Trading Toxics

Waste, Then and Now

What Goes Around Comes Around

What Is Evaporation?

When the Gears Don't Mesh

APPENDIX E

ACTIVITIES LISTED BY SCHOOL SUBJECT

SOCIAL STUDIES

2001: A Trash Odyssey

A Careful Consumer's Trip to the Grocery Store

A Hazardous Debate

Bikes and By-Products

Consequences of Litter

Deciding What to Do

Ecological Picnic

Extra Fancy Duds

Finding Community Resources

Hazardous Substances Around School

Hazardous Waste Hot Potato

Hazardous Waste In My Home Town?

Incineration

Incredible Edible Chemical Landfill

Introducing the 3 R's

Is My Business Your Business?

Making Paper

Model City Relay

Natural Resources: Handle With Care

Needs and Wants

NIMBY

Nonrenewable Resources: How Long Will They Last?

Not Everything Made From Scratch Is the Best

Nowhere Is Away

Nurture Some Nature

Oil Spill

Plastic Is a Problem

Plastic Trash and Wildlife

Poison That Looks Like Food

Read the Label

Risks and Benefits

Safe Substitute Card Game

Safety the Housekeeper

Site Unseen?

Solid Waste: What's My Responsibility?

Something Old, New, Borrowed, Blue

Take a Bite of the Finite

Take-Home Recycling Kit

The Big Three of Toxics

The Legacy of Love Canal

The Problem With Landfills

The Throwaway Three

Toxic-Free Bingo

Trading Toxics

Waste, Then and Now

Water Charades

What Goes Around Comes Around

What Is Garbage to You May Be Gorgeous to Me

What's In a Cycle?

SCIENCE

1 + 1 = ?

2001: A Trash Odyssey

A Healthy Respect for Hazards

Balance In an Aquatic Community

Be a Garbage Detective

Bikes and By-Products

Characteristics In an Aquatic Community

Consequences of Litter

Deciding What to Do

Ecological Picnic

Extra Fancy Duds

Finding Community Resources

Hazardous Substances Around School

Hazardous Substances In My Home?

Hazardous Waste Hot Potato

How Do I Feel?

Incredible Edible Chemical Landfill

Is My Business Your Business?

Model City Relay

Monitoring Particles In the Air

More Than Meets the Eye

Necessary Wrappers?

Needs and Wants

Not Everything Made From Scratch Is the Best

Oil and Water Don't Mix

Oil Spill

Plastic Is a Problem

Poison That Looks Like Food

Read the Label

Risks and Benefits

Safety the Housekeeper

Selling a Safer Alternative

Site Unseen?

Solubility In Water

Sulfur Dioxide Dangers

Super Cycle

The Big Three of Toxics

The Legacy of Love Canal

The Not So Gentle Rain

Trading Toxics

Using Groundwater Models

Water Charades

What Goes Around Comes Around

What Is Evaporation?

What Is Oil Really Like?

What's In a Cycle?

When the Gears Don't Mesh

CHEMISTRY

1 + 1 = ?

How Very Little It Must Be

Oil and Water Don't Mix

Sulfur Dioxide Dangers

HOME ECONOMICS

A Careful Consumer's Trip to the Grocery Store

A Healthy Respect for Hazards

Hazardous Substances In My Home?

Plastic Trash and Wildlife

Read the Label

Safe Substitute Card Game

Toxic-Free Bingo

Waste, Then and Now

PHYSICAL EDUCATION

Model City Relay

ART

Be a Garbage Detective

Consequences of Litter

Logos and Slogans for Recycling

Making Paper

Selling a Safer Alternative

Something Old, New, Borrowed, Blue

Take-Home Recycling Kit

The Art of Solid Waste

Word Puzzle

DRAMA

Selling a Safer Alternative

The Throwaway Three

Water Charades

LANGUAGE ARTS

Be a Garbage Detective

Consequences of Litter

Finding Community Resources

How Do I Feel?

Incineration

Needs and Wants

Nurture Some Nature

Oil Spill

Selling a Safer Alternative

Take-Home Recycling Kit

The Throwaway Three

What Is Garbage to You May Be Gorgeous to Me

When the Gears Don't Mesh

Word Puzzle

GOVERNMENT

Deciding What to Do

NIMBY

GEOGRAPHY

Hazardous Waste In My Home Town?

Nonrenewable Resources:
How Long Will They Last?

Site Unseen?

GEOLOGY

Using Groundwater Models

ECONOMICS

Hazardous Waste In My Home Town?

Plastic Is a Problem

HEALTH

A Hazardous Debate

A Healthy Respect for Hazards

Hazardous Substances In My Home?

Read the Label

The Big Three of Toxics

Trading Toxics

How Very Little It Must Be
Incineration
Is My Business Your Business?
Mini Water Treatment Simulation
Monitoring Particles In the Air
Necessary Wrappers?
Nonrenewable Resources: How Long Will They Last?
Not Everything Made From Scratch Is the Best
Nowhere Is Away
Oil Spill
Take a Bite of the Finite
The Not So Gentle Rain

SHOP

Oil and Water Don't Mix
Oil Spill

BIOLOGY

Plastic Is a Problem
Sulfur Dioxide Dangers

MATHEMATICS

Characteristics In an Aquatic Community
Extra Fancy Duds
Finding Community Resources

APPENDIX F

ACTIVITIES LISTED BY TOPIC

RESOURCES

Natural Resources: Handle With Care

Nonrenewable Resources:
How Long Will They Last?

Not Everything Made From Scratch Is the Best

Take a Bite of the Finite

What's In a Cycle?

WATER

How Very Little It Must Be

Mini Water Treatment Simulation

More Than Meets the Eye

Oil and Water Don't Mix

Site Unseen?

Solubility In Water

The Legacy of Love Canal

The Not So Gentle Rain

Using Groundwater Models

What Goes Around Comes Around

What Is Evaporation?

What Is Oil Really Like?

When the Gears Don't Mesh

AIR

Incineration

Monitoring Particles In the Air

Sulfur Dioxide Dangers

The Not So Gentle Rain

POLLUTION

Nurture Some Nature

Oil Spill

Sulfur Dioxide Dangers

The Legacy of Love Canal

What Is Oil Really Like?

SOLID WASTE

2001: A Trash Odyssey

A Careful Consumer's Trip to the
Grocery Store

Be a Garbage Detective

Consequences of Litter

Deciding What to Do

Ecological Picnic

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Incineration

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Needs and Wants
Nowhere Is Away
Nurture Some Nature
Plastic Trash and Wildlife
Site Unseen?
Solid Waste: What's My Responsibility?
Take-Home Recycling Kit
The Art of Solid Waste
The Problem With Landfills
The Throwaway Three
What Is Garbage to You May Be Gorgeous to Me

LITTER

2001: A Trash Odyssey
A Careful Consumer's Trip to the Grocery Store
Be a Garbage Detective
Consequences of Litter
Deciding What to Do
Ecological Picnic
Extra Fancy Duds
Incineration
Incredible Edible Chemical Landfill
Logos and Slogans for Recycling
Model City Relay
Necessary Wrappers?
Needs and Wants
Nowhere Is Away
Nurture Some Nature
Plastic Trash and Wildlife
Site Unseen?
Solid Waste: What's My Responsibility?
Take-Home Recycling Kit
The Art of Solid Waste
The Problem With Landfills
The Throwaway Three
What Is Garbage to You May Be Gorgeous to Me

RECYCLING

2001: A Trash Odyssey
Be a Garbage Detective
Consequences of Litter
Ecological Picnic
Introducing the 3 R's
Logos and Slogans for Recycling
Making Paper
Model City Relay
Needs and Wants
Not Everything Made From Scratch Is the Best
Nowhere Is Away
Plastic Is a Problem
Solid Waste: What's My Responsibility?
Something Old, New, Borrowed, Blue
Take-Home Recycling Kit
The Art of Solid Waste
The Throwaway Three
Waste, Then and Now
What Is Garbage to You May Be Gorgeous to Me

HAZARDOUS WASTE

Bikes and By-Products
Incredible Edible Chemical Landfill

Is My Business Your Business?
NIMBY
Risks and Benefits
Site Unseen?
The Legacy of Love Canal
Trading Toxics

CONSUMERISM

A Careful Consumer's Trip to the Grocery Store
A Healthy Respect for Hazards
Extra Fancy Duds
Necessary Wrappers?
Take-Home Recycling Kit

RISK

Risks and Benefits

HOUSEHOLD HAZARDOUS SUBSTANCES

1 + 1 = ?
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Hazardous Substances Around School
Hazardous Substances In My Home?
Hazardous Waste Hot Potato
Hazardous Waste In My Home Town?
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Toxics-Free Bingo
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